THE BULLETIN

OF THE

AMERICAN CERAMIC SOCIETY

Volume 15 APRIL, 1936 Number 4

Photo: courtesy of F. W. Preston

JOHN PEATE

In 1895, at the age of seventy-five, the Reverend Doctor John Peate, superannuated Methodist minister who figured telescope mirrors for a pastime, began the two-year task of grinding and polishing a 62-inch glass telescope mirror for the Methodist-Episcopal American University, Washington, D. C. During the polishing of the mirror, a demonstration with which Peate delighted in entertaining visitors was to pull out one of his long white whiskers, hang it on a fence nearly a quarter of a mile away, and show its image as reflected from the mirror surface. In mid-July, 1897, Peate announced that the mirror was finished. For the complete story see page 129.

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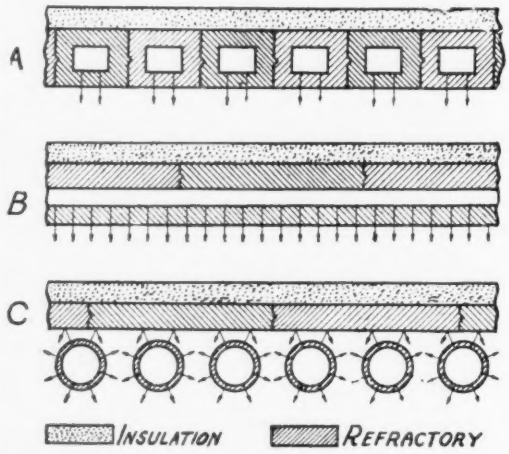

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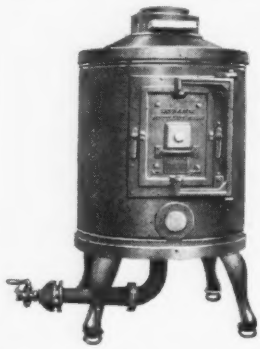

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Ingram-Richardson Mfg. Co. of Indiana, Inc.
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Titanium Alloy Mfg. Co.
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Norton Co. (*Alundum-Crystolon*)

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The DeVilbiss Co.

Iron (Enameling)
American Rolling Mill Co.
Bethlehem Steel Co.

Iron Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Porcelain Enamel and Mfg. Co.
The Vitro Mfg. Co.

Kaolin
Ceramic Color & Chemical Mfg. Co.
Consolidated Feldspar Corp.
Edgar Brothers Co.
Edgar Plastic Kaolin Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
United Clay Mines Corp.

Kellogg AA Refractories
Electro Refractories & Alloys Corp.

Kilns, China (Decorating)
Allied Engineering Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Simplex Engineering Co.

Kiln Furniture (Silicon Carbide, Semi-Silicon Carbide)
Electro Refractories & Alloys Corp.

Kryolith
Ceramic Color & Chemical Mfg. Co.

The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
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Carborundum Co.
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Norton Co.
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Ceramic Color & Chemical Mfg. Co.
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Drakenfeld & Co., B. F.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Manganese (Oxide)
Ceramic Color & Chemical Mfg. Co.
Corhart Refractories Co.
The Roessler & Hasslacher Chemical Co.

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The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Mixers (Batch)
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Mold Sanders
Lancaster Iron Works, Inc.

Muffles (Furnace)
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Ferro Enamel Corp.
Norton Co.
Pittsburgh Plate Glass Co.
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Muffles (Laboratory)
Electro Refractories & Alloys Corp.

Mullite (Refractories)
Electro Refractories & Alloys Corp.

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Denver Fire Clay Co.
The Hommel Co., O., Inc.

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Non-Gro Refractories
Electro Refractories & Alloys Corp.

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Norton Co.

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Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Oxides
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Ferro Enamel Corp.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Pins
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
The O. Hommel Co.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Potters Supply Co.

Polariscopes
Bausch & Lomb Optical Co.
Simplex Engineering Co.

Porcelain Enameling Service (Practical)
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Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel & Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
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The Roessler & Hasslacher Chemical Co.
Solvay Sales Corp.
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Producer Glass Plants
Simplex Eng. Co.

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Pyrometer Tubes
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Electro Refractories & Alloys Corp.

Pyrometer Tubes (Refractory and Hard Porcelain)
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Norton Co.

Pyrometric Cones
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Refractory Materials
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Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Saggers
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Potters Supply Co.

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The O. Hommel Co.

Sandblast Helmets
Willson Products, Inc.

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Lancaster Iron Works, Inc.

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The O. Hommel Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Vitro Mfg. Co.

Selenium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sheets (Enameling Iron)
American Rolling Mill Co.
Bethlehem Steel Co.

Silica (Fused)
Electro Refractories & Alloys Corp.
The Hommel Co., O., Inc.

Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.

Silicon Carbide
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.

Silicon Carbide Firesand
Carborundum Co.

Sillimanite Refractories
Electro Refractories & Alloys Corp.

Sillimanite (Synthetic)
Pittsburgh Plate Glass Co.

Slabs (Furnace)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Pittsburgh Plate Glass Co.

Smelters
Ferro Enamel Corp.

Soda Ash
American Potash and Chemical Corp.
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
The Hommel Co., O., Inc.
Pittsburgh Plate Glass Co.
The Roessler & Hasslacher Chemical Co.
Solvay Sales Corp.
The Vitro Mfg. Co.

Sodium Antimonate
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Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Sodium Fluoride
Ceramic Color & Chemical Mfg. Co.
Denver Fire Clay Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

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Ceramic Color & Chemical Mfg. Co.
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Spar
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Consolidated Feldspar Corp.
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The Roessler & Hasslacher Chemical Co.

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Potters Supply Co.
Sulfuric Acid
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The Hommel Co., O., Inc.
Talc
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
Tanks
Simplex Engineering Co.
Tank Blocks
Corhart Refractories Co.
Pittsburgh Plate Glass Co.
Tanks (Pickle)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
The O. Hommel Co.
Tanks for Raw Material Steel or Concrete
Bethlehem Steel Co.
Lancaster Iron Works, Inc.
Tile (Floor)
Norton Co.
Tile (Muffle)
Carborundum Co.
Electro Refractories & Alloys Corp.
Norton Co.
Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Chicago Vitreous Enamel Product Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
Norton Co.
Pittsburgh Plate Glass Co.
Tile (Wall)
Denver Fire Clay Co.
Ferro Enamel Corp.
Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.
Titanium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.
Trucks
Lancaster Iron Works, Inc.
Tubes (Insulating)
Carborundum Co.
McDanel Refractory Porcelain Co.
Norton Co.
Tubes (Pyrometer)
Carborundum Co.
Denver Fire Clay Co.
Electro Refractories & Alloys Corp.
McDanel Refractory Porcelain Co.
Norton Co.
Pittsburgh Plate Glass Co.
Water Softening Plants
Simplex Eng. Co.
Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
The Hommel Co., O., Inc.
Ingram-Richardson Mfg. Co. of Indiana, Inc.
Porcelain Enamel & Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.
Whiting
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Hammill & Gillespie, Inc.
The Hommel Co., O., Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
Winding Drums
Lancaster Iron Works, Inc.
Zinc Oxide
Ceramic Color & Chemical Mfg. Co.
The O. Hommel Co.
The Vitro Mfg. Co.
Zirconia
Ceramic Color & Chemical Mfg. Co.
The Hommel Co., O., Inc.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
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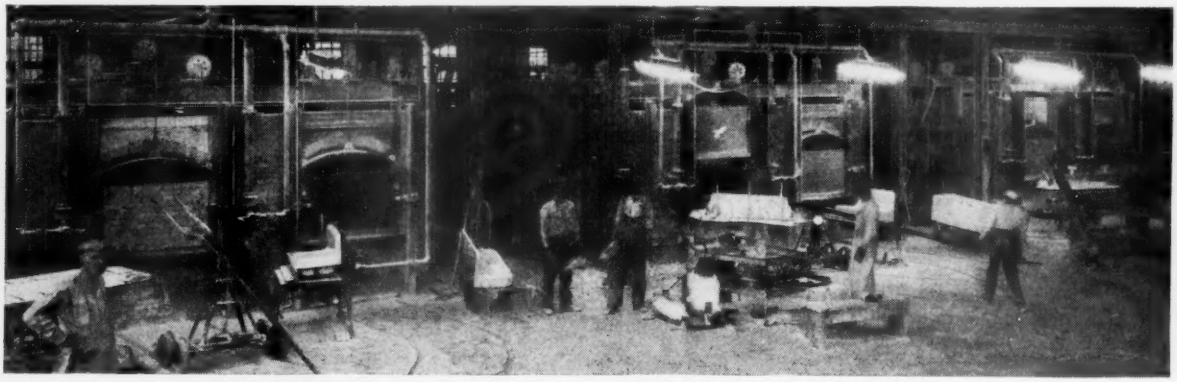

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BETHLEHEM 88-80 Castings oppose to abrasive materials an array of properties that sharply reduces maintenance on grinding machinery. 88-80 was developed through long research focused on the problem of increasing resistance to abrasive wear. Not only was this object achieved but a material was produced which in other respects, too, is better fitted to stand up to the job.

The high wear resistance of 88-80 castings extends all the way through. There's no relatively soft center to give way rapidly after the surface is gone Every inch of thickness is good for the same long, stubborn resistance to wear. And there's no tendency to wear concave. The hardness is uniform all the way across the face. For the same reason corners do not chip off. The castings retain an efficient grinding surface throughout their life.

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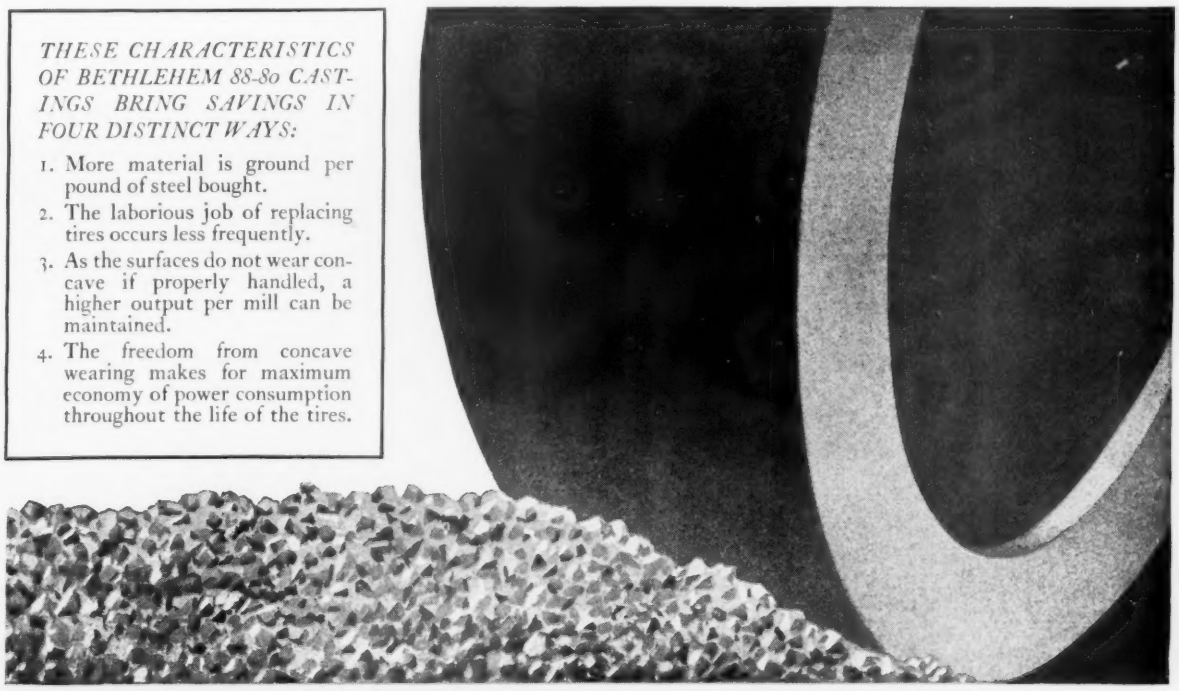

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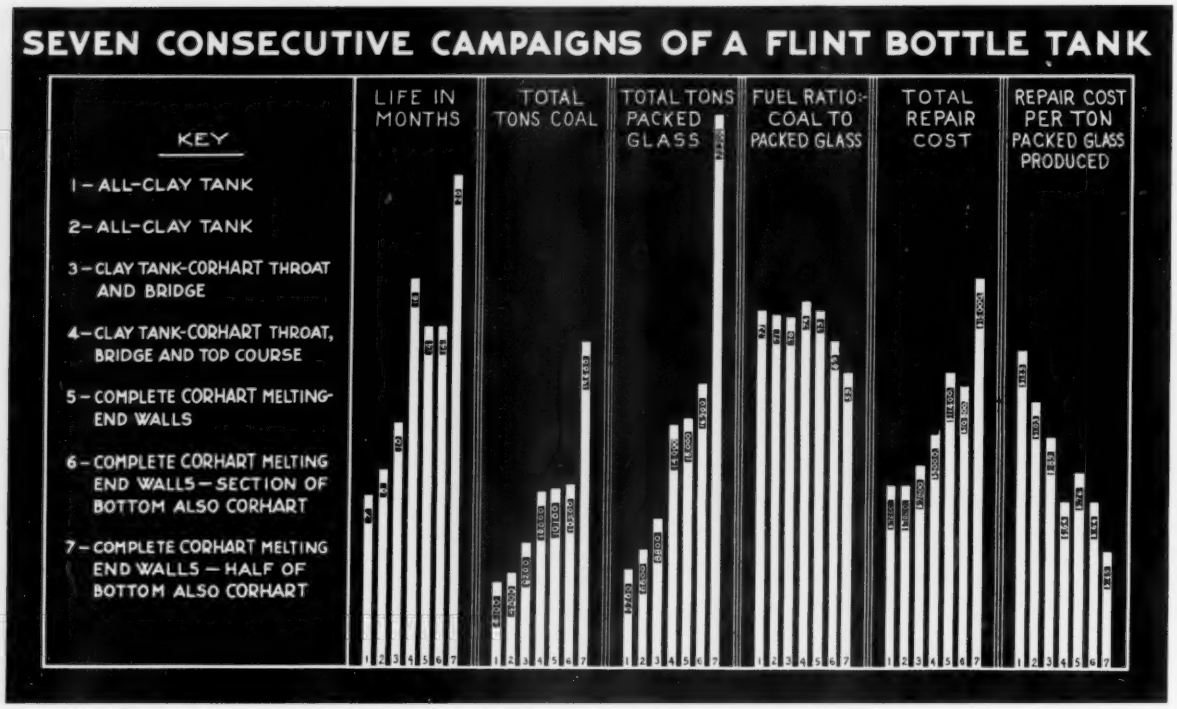
SEVEN CONSECUTIVE CAMPAIGNS OF A FLINT BOTTLE TANK
KEY
1 – ALL-CLAY TANK
2 – ALL-CLAY TANK
3 – CLAY TANK-CORHART THROAT AND BRIDGE
4 – CLAY TANK-CORHART THROAT, BRIDGE AND TOP COURSE
5 – COMPLETE CORHART MELTING-END WALLS
6 – COMPLETE CORHART MELTING END WALLS – SECTION OF BOTTOM ALSO CORHART
7 – COMPLETE CORHART MELTING END WALLS – HALF OF BOTTOM ALSO CORHART
LIFE IN MONTHS
TOTAL TONS COAL
TOTAL TONS PACKED GLASS
FUEL RATIO-COAL TO PACKED GLASS
TOTAL REPAIR COST
REPAIR COST PER TON PACKED GLASS PRODUCED

7 FIRES AT ONE GLANCE

THE chart above gives, at one glance, the entire cost-data of a momentous case-history, which was eight long years in the making—the history of *one tank* during seven consecutive fires, starting on all-clay construction and ending with the extensive use of Corhart Electrocast.

Life. Please note that, in the gradual change from clay to Corhart, life has been increased from 7 months to 20 months—and this in spite of the fact that daily pull has been almost doubled.

Packed Glass. Please note that *packed* glass has risen from 5,700 tons to 32,300 tons per fire—a net *increase* of 466%.

Repair Cost per Ton of Glass. Here is the crux of the whole situation. By greatly increasing life and output, even at a considerable extra repair cost, this manufacturer has reduced his repair-cost-per-ton from the former figure of $1.25 to a record low of 45 cents per ton—a reduction of 63½% and a saving of 78 cents for every ton of glass *packed.*

In studying this chart, please bear in mind that the actual figures of cost are not so important as the *percentage of change.* Every furnace is different, and it may very possibly be true that your furnaces are producing better records than those shown above. The point to consider is that, over a long period of time, these costs have been progressively lowered, and that Corhart Electrocast has been one of the prime factors in their progress.

Corhart Refractories Co., Incorporated, 16th and Lee Sts., Louisville, Ky. *In Europe:* L'Electro Refractaire, Paris. *In Japan:* Asahi Glass Co., Tokio.

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Volume 15 **April, 1936** **Number 4**

PAPER

THE FIRST BIG AMERICAN TELESCOPE MIRROR*
JOHN PEATE, HIS LENS

By F. W. Preston

Summary

We begin with legends and traditions and sift out the facts as best we can. When this account was first written, scarcely any two stories agreed. It is believed, however, that the final version now presented gives both the tradition and the facts fairly accurately; at any rate the sources of information are indicated. Fortunately, through the kindness of John Morrison, we have come into possession of a pencil manuscript of Dr. Peate's dated 1898, which indicates much more clearly than any of the other contemporary records just what Peate did and what he knew. It also indicates the attractive balance of poet and mechanic in his character.

The great mirror was cast in Butler, Pa., in 1895; the machinery for working it was made in Greenville, Pa., in 1894–95, and the mirror was edged, ground, and polished there in 1895–97. It was shipped in 1898 to Washington, D.C., and at the present time it is at the National Museum.

The Legend

The Reverend Doctor John Peate was past seventy years of age, seventy-three to be exact, in the year of our Lord eighteen hundred and ninety-three, when the Erie Conference[1] of the Methodist-Episcopal Church met in Dubois, Pennsylvania, in September of that year. In twelve months' time Peate was due to be superannuated, and the prospect filled him with consternation.

"What am I to do all the rest of my life?" he asked, for he was still a man of great vigor and had every prospect of living many years.

"Oh, study astronomy," said the Bishop.[2]

"Make a big telescope lens," said one of his colleagues, Dr. Wythe, himself a microscopist and maker of small lenses.[3] "Here's a pamphlet that tells you how to do it. It is just the job for you."

Peate read the little book and was at once interested. He was a man of extraordinary manual skill and was anxious to get to work at once.

At this time the new Methodist-Episcopal University at Washington, D. C., known as the American University, had just received its charter (1893), and the presiding bishop at the Dubois meeting, Dr. Hurst, was also the chancellor of the new university. Urged on by Wythe, Peate announced to the gathering:

"I will make for the new university the biggest

* Presented at the Annual Meeting, American Ceramic Society, Buffalo, N. Y., February, 1935 (Glass Division). Received January 22, 1936.

[1] In the M.-E. church, a "Conference" is a district which holds an annual meeting: it is not the meeting itself which is the "Conference."

[2] Version of George Lambert, to whom Peate told the story in 1895.

[3] Version of John Morrison, in *The Evening Record*, Greenville, Pa., March 24, 1903.

telescope lens in the world, if you will defray the out-of-pocket expenses."[4]

The meeting considered the project favorably.

"Well, how big a lens can you make?" asked the bishop.

"Oh, as big as that chart on the wall,"[5] said Peate, indicating the first thing that caught his eye.

"Get a rule and measure the chart," said the bishop. It turned out to be 62 inches across.

"Offer accepted. One 62-inch reflecting telescope mirror from Dr. Peate," said Hurst, and when the Conference adjourned, Peate began laying his plans and looking for a source of raw material.

> Until in his seventy-fifth year he had absolutely no technical knowledge of the laws of optics nor any practical experience in the making of lenses.[6]
>
> He made at first several small glasses more or less successfully, presenting them to colleges in which he was interested, where they were mounted and are still in use.[7]

With this slight preparation and the skill of a genius, Peate set out to construct the largest telescope mirror in the world and succeeded.

This is the picturesque version, and the one very commonly believed. It appears unequivocally in print in the *University Courier* in Peate's obituary notice as quoted above.

The Fact

The real story is less incredible and vastly more creditable to Peate. This was no slap-dash undertaking, but the crowning effort of many long years of work. Peate's offer was not based on flighty ignorance, but on the positive knowledge that he could accomplish it if his life should be spared for three or four years. He had been making telescope lenses and mirrors for sixteen years[8] and had already made fifteen of them,[9] in gradually increasing sizes from a 3-inch diameter[10] to about 30 inches[11] or perhaps 36 inches.[11a] He knew exactly what he was undertaking and he was one of three men—only three—in the United States who could figure telescope mirrors.[12]

It is apparently true that it was Dr. Wythe who suggested telescope-making as an occupation for old age,[13] but Peate's inquiry on this subject was sixteen years or so before superannuation was due. Peate was in the habit of looking ahead and taking his preparations seriously, even from boyhood, if we may judge from the story on page 133, and he did not wait until within a year of his retirement to prepare himself an absorbing occupation for his last years. It is also reported that Wythe was still backing Peate at the 1893 Conference and urging him to tackle the giant "lens" for the new university.[14]

The first of Peate's lenses was a 3-inch refractor; his second a 6-inch. This, apparently, he mounted in a telescope tube and set up for himself a little observatory at his home in Greenville, Pa.[10] He also gathered together there a library of formidable and profound scientific books.[15] But his interest lay much less in observing with the telescope than in constructing telescopes and in the mechanics of the thing.[10] He knew that there were many men capable of using a telescope with good effect but exceedingly few who could make them. He was interested in making bigger and bigger telescopes, so that man might see further and further into the heavens—not simply in making a large number of telescopes, but in making them more and more powerful. He seems from the very start to have recognized that his last work on earth would be the construc-

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[4] Minutes of the Erie Conference, 1893, p. 29: "Proposition of John Peate." "John Peate made a proposition to manufacture a large reflecting lense for the University, providing material for the same was furnished him. On motion of Naphtali Luccock, the thanks of the Conference were tendered Brother Peate for his generous proposition, and a committee of five was appointed to take the same into consideration. R. N. Stubbs, G. H. Humason, N. T. Arnold, G. P. Hukill, and G. B. Chase were appointed that committee.

"J. A. Kummer called the attention of the Conference to a former proposition of Brother Peate to donate a lense to Allegheny College (Meadville, Pa.) and, on motion of Brother Kummer, this proposition also was referred to the same committee."

(The R. N. Stubbs above mentioned is the author of Peate's obituary notice in the Minutes of the Erie Conference, 1903. See p. 133 of present memoir.)

[5] The story of the chart is attested by many independent witnesses, who had it from Dr. Peate direct.

[6] *University Courier* (organ of the American University, Washington, D. C.), Oct., 1903, p. 1; quoted verbatim.

[7] *Ibid.*, p. 2.

[8] *Ibid.*, June, 1895, p. 5.

[9] The 62-in. lens made his sixteenth (*University Courier*, Nov., 1898, p. 4); but Morrison makes it fourteen mirrors. (See Epilogue, p. 151.)

[10] According to F. W. Stone, Ashtabula, Ohio, private letters, Dec., 1934.

[11] According to John Morrison, Greenville, Pa.; also *University Courier*, Sept., 1894, p. 6.

[11a] Private communication from his daughter, Miss Minnie Peate, Feb. 8, 1935.

[12] According to George Lambert of Harmony, Pa.

[13] *Greenville Record Argus* (probably Dec. 17, 1903).

[14] J. N. Fradenburgh, History of the Erie Conference, Vol. II, p. 476 (1907). Derrick Publ. Co., Oil City, Pa.

[15] R. N. Stubbs obituary notice of Peate (Minutes of Erie Conference, 1903).

tion of the biggest telescope objective[16] in existence.

Beyond the 6-inch size Peate could not well proceed with "refractors," that is, transmitting lenses: he had to come to "reflectors" or mirrors. The cost of the glass blank would otherwise be beyond his purse. In any case, it would be necessary to come to reflectors sooner or later, as glass could not be obtained at all for refractors of huge size.

He began with relatively small reflectors, apparently making them of glass imported from France (Saint Gobain). A discussion of these is given in Appendix I, as far as they can be traced. One is at Thiel College, Greenville, securely packed in its original case.[17] This is said to be 22 inches in diameter. There is a mirror at Allegheny College, Meadville, Pa.,[18] whose history is unknown at the college except that it is "rather old," but the writer has little doubt it is one of Peate's from other testimony.[19] One of Peate's mirrors went to India,[20] and a number are said to have been put to use in the United States. At the moment their whereabouts are uncertain (see Appendix I pp. 147 and 148), but before his superannuation Peate had reached a size around 30 inches and had ground, polished, and figured the mirror successfully.[21]

By these long years of discipline and study Peate had fitted himself for his great task, and the time was at hand for him to begin it. Strictly speaking, Peate was not superannuated in 1894, but was "made a supernumerary." His superannuation came in 1898.[14] But none the less he was free to begin his great mirror in 1894 and was authorized to do it in 1893. His mirror was actually completed a few months before he was officially superannuated in 1898.

Peate wrote to Saint Gobain for a quotation on the mirror blank, *i.e.*, the rough disk of glass, and the price quoted was $18,000.[22] Saint Gobain has always had a reputation for making excellent glass for this purpose, and there is no doubt Peate would have obtained a well-made, well-annealed piece of glass from them for this price. Most of his previous glass had come from there. But he felt the present quotation was impra-

[16] The term "objective" is used here in its technical sense. As applied to telescopes it means the big *lens* or the big *mirror*, either one or the other, according to the type of telescope, which the light strikes first after leaving the *object*, in this case a star or other heavenly body.

[17] Miss Florence A. Beaver, Secretary of Thiel College. (Private communication, Nov. 23, 1934). The latest information, from H. H. Harman, a trustee of Thiel College, is that the Thiel mirror is 22 in. in diameter. This, therefore, is not Peate's first reflector, but one of the latest ones. Private communication from John Morrison, Feb. 6, 1935. See Appendix I, p. 147.

[18] C. W. Ufford, Physics Dept., Allegheny College, private communication, Nov. 27, 1934.

[19] According to John Morrison (in conversation).

[20] *Greenville Record Argus*, Dec. 17, 1903.

[21] These are technical terms. "Grinding" is abrading with such a material as emery rubbed on with a hard tool of cast iron or similar character; this leaves a "ground glass" surface. "Polishing" is rubbing with rouge (iron oxide) on a soft tool such as felt or pitch or wax. "Figuring" is giving the correct parabolic contour by locally abrading away the high spots, determining where the latter are by continual testing by optical means.

[22] Version of George E. Howard.

Fig. 1.—The "Standard Plate" at Butler, Pa., where the big lens was cast. The exact spot where the casting was done is marked by an *X*.

ticably high.[23] There is some evidence that the Erie Conference had set a limit to the total expenditures and that this limit would not permit such an expense for the rough blank.

Peate therefore began a hunt for a less expensive source and, after meeting with no encouragement among the firms of the Pittsburgh district proper, he approached the Standard Plate Glass Company[24] of Butler, Pa., which had recently been put on its feet by Henry Troutman. The plate-glass industry in America, as other than a losing proposition, was scarcely ten years old, and the Butler plant was even less.

The general manager was H. C. Tilton.[25] Dr. Peate wrote to him asking for a disk of glass, without bubble or flaw, 62 inches in diameter and 7 inches thick, advising him that he would see him in a few days.

The day superintendent was Louis R. Schmertz[26] and the night superintendent, George Lambert[27]; the business of these men was to make routine plate glass, not to tackle the monstrous proposition of John Peate. So Tilton called George Howard,[28] who had graduated from Cornell a year before, and was acting as maintenance engineer of the plant. The same it is who thirty years later, when the present writer first came to Butler, had developed the Howard feeder for bottle machines and other noteworthy inventions.

"Howard, here's a man at Greenville who wants us to cast him a disk 62 inches in diameter and 7 inches thick. Is that possible?"

Howard calculated the cubical contents of the proposed disk and replied, "Why, yes. If we fill one of our pots full to the brim, and don't take too much off in the skimming, it will be just about right."

"Well, aren't there unusual difficulties in casting glass so thick?"

"Oh, I don't see any particular difficulties. We might lose the first two or three attempts, but I don't see what's to stop us making it after one or two times." George Howard had not been out of school long enough to realize that glass-making could possibly present any difficulty. He afterward freely ascribed his success in this instance to his ignorance.

"Well," continued Tilton, "this Dr. Peate is coming down here tomorrow, and he wants a quotation. How much do you think we ought to ask?"

"We'll have some special apparatus to make and some experimenting to do. Then we'll probably lose two or three pots of glass. I think you'd better ask him $800." George thought he was putting the price plenty high.

Tilton was more cautious. "I'll double it. You might lose more than you think. The fellow will probably kick, and we can come down a bit if necessary." It is probable that Mr. Tilton did not particularly want the job for, although he knew no more about this particular job than Mr. Howard, he knew the latter's natural optimism and had an inkling, perhaps from Peate's letter, that it was not generally considered a simple matter to cast a perfect telescope mirror blank.

FIG. 2.—George Howard in 1895.

A day or two later, Dr. Peate showed up in Butler in the dingy old offices of the Standard Plate. George Howard was invited to sit in at the interview.

Tilton began to break the ice gently.

"Dr. Peate, this is a difficult and unusual undertaking. We shall probably have a number of failures before we produce a blank satisfactory to you. We shall have to ask sixteen hundred dollars."

[23] Version of Geo. Lambert (letter of 1922 to Dodds, see footnote 57).

[24] This company had a reputation for making the best plate glass in the country at the time.

[25] Since deceased.

[26] Now of Pittsburgh; for many years Mr. Schmertz was connected with the American Window Glass Co.

[27] Now of Harmony, Pa.

[28] Now consulting engineer of the Hartford-Empire Co., but resident still at Butler, Pa.

"Oh, that'll be all right—that'll be all right," said Peate instantly.

Tilton was now fairly on the spot. Peate's instant acceptance of the contract convinced him more than ever that there was some catch in the whole matter and that the job was going to be more difficult than Howard had imagined. He had no idea that Peate would be willing to pay so extravagant a sum, but then he did not know that Saint Gobain had quoted over ten times as much.[29]

So the contract was placed, apparently in October, 1894.[30]

As a matter of fact, the price ultimately charged was only $450. Tilton had protected himself against unforeseen trouble by quoting the higher figure, but in the end he or Henry Troutman decided that they were not interested in making a profit on the undertaking but would help the old preacher at cost.

"This is going to be my last work on earth," said Peate. "It will take me three years to grind and figure the glass, and I shall then be seventy-seven or eight. I can not expect to live much longer."[31]

The telescope into which the mirror was to go was apparently intended by his colleagues as a memorial to the old circuit rider.

"It is to be a monument to Reverend Doctor John Peate and much more significant than any costly column that might be erected to the memory of the old gentleman."[30]

John Peate was born in Drumskelt, parish of Ahbog, County Monaghon in northern Ireland, May 6, 1820. His family came to Quebec in July, 1827, when he was seven years old.[32] From there they moved in 1828 to Vergence, and Wilsborough, Vermont, but later returned to Canada (Kingston, Ontario), in the fall of 1832. In 1835 they located at Oswego, N. Y., and in 1836 at Buffalo.[33]

The story is told that Peate was waylaid by the local bully as he was carrying home the milk. Peate was beaten up and the milk spilled. He promptly sought out a professional boxer and took boxing lessons till he became proficient. He then issued a challenge to the bully in question and gave him a very sound public trouncing.[34]

At an early age he was apprenticed to the bricklaying trade and, in after years, he used to pat affectionately the bricks of buildings which he had erected in Buffalo. He is said to have himself made amateur trigonometrical surveys of Niagara Falls, with a view to determining its rate of recession,[35] but the same work had been done, I think, by professionals much earlier.

Stubbs[32] described him thus, "One of the finest physical specimens of man. About five feet eight inches, erect, 150 to 160 pounds, muscular, finely formed, black hair, patriarchal beard, eyes dark, bright, and kindly, features strong, a skull like the dome of the skies."

In his twenties, Peate was "converted," and throwing his hat, coat, and collar into the melée as usual, he decided to quit bricklaying and become a preacher. To that end, he entered Oberlin College in 1840 or thereabouts, but the death of his father in 1844 forced him to return home to take charge of the family without completing his college course.[36] He was "licensed" in 1849 by the Methodist-Episcopal Church and held various pastorships of the Erie, Pennsylvania, circuit, preaching at Erie, Akron, Youngstown, Jamestown, and Greenville, among other places. In 1845 he married Mary E. Tilden of Buffalo, a relative of President Fillmore, and had ten children, five daughters and five sons, of whom four daughters and one son survived him in 1903.[37]

In 1859–1860 Peate left on the Bremen, one of the largest iron-screw steamers of the day, some 360 feet long, 50 feet wide, and "40 deep," for a pedestrian tour of Europe and the Near East. Memoranda of John Morrison show that in July (presumably of 1859) he was in Southampton, London, and Liverpool (July 23), thence to the

[29] Information principally from G. E. Howard.

[30] *China, Glass, and Lamps* [Pittsburgh] 9 [14] 17 (March 13, 1895) (in Library of Congress).

[31] Quoted by George Lambert.

[32] R. N. Stubbs' obituary notice of Peate (Minutes of Erie Conference, 1903, p. 90) says he came to America at the age of nine. There is scarcely a thing on which the histories agree.

[33] J. N. Fradenburgh, History of the Erie Conference, Vol. II, pp. 204–11 (1907).

[34] In this early example of Peate's methodical preparation for a task, we may well see an adumbration of his years of preparation for making the big mirror.

[35] According to John Morrison.

[36] Fradenburgh thus gives Peate about four years in college, but Stubbs (footnote 32) says, "All the schooling of his life could be packed into two years at most," and Morrison's recollection is that Peate told him he was never in any school in the capacity of a student.

His daughter describes the legend that he never went to school one day in his life as one of the most frequent of the "grave errors" commonly printed about her father. (Private letter, Feb. 8, 1935).

[37] Obituary notice of Elizabeth Tilden Peate by C. S. Borland, Minutes of Erie Conference, 1907, p. 117.

Isle of Man, on to Ireland (Dublin and Belfast and possibly to his boyhood home), and to Scotland (Edinburgh) in August. He was again in London in August and September, 1859, traveling thence through Holland and up the Rhine, entered Switzerland and, with knapsack on his back, climbed over the passes into Lombardy. He was at Lake Como, Venice, and Trieste before September 26, and thence sailed to Egypt, where he was in Cairo by October 15. The same month saw him in the Convent of Mount Sinai and November in Jerusalem. Thence he passed to Damascus and Baalbeck and returned to the Nile for a month or two (December, 1859 to February, 1860). He was at Naverino, Greece, on February 18, and reëntered Italy by way of Messina, reaching Naples on March 6; he made no notes of his subsequent visits to Rome or his journey through France. He had, however, written such interesting accounts of his great hike in his letters home that many of them were translated into foreign languages.

After his return, the Erie Conference, sitting that year at Erie, voted unanimously requesting him to publish his writings in a book, but Peate said he had no interest in such a proposal, and apparently nothing more was done about it.

In 1870 Peate made a trip through the Western States, as far as San Francisco. This presumably was the occasion on which he visited Lick Observatory where, according to Stubbs, he was already recognized as "a child of the stars," although his mirror-making had, according to the best evidence we have, begun only a year or two earlier.

Of his mirror-making activities, Peate seems to have left no account whatever except a pencil manuscript of notes for a lecture. Fradenburgh's History of the Erie Conference,[14] which gives seven or eight pages to a biography of Peate, makes only the most meager mention of his activities in the astronomical and mirror-making field. All that it says is as follows:

> Astronomy presented a rich field for his research . . . and called for fine mechanical skill . . . and for years astronomical science has become so interesting as almost to eclipse his other work. His genius in this line has placed the preacher on the highest elevation of applied science and given him a world-wide recognition as a maker of telescope reflectors.

There is little doubt that the Methodist-Episcopal fraternity were a little worried over Peate's peculiar activity of telescope making; they did not understand it, failed to see the utility of it, and did not consider that souls would be saved by it. It seemed to them that Peate was a mighty preacher who was losing interest in the spreading of the gospel due to his absorption in lens manufacture.

> Stagnation did not exist where John Peate preached. He threw bomb shells; he antagonized; he agitated; he quickened. His friends boasted him to the skies, and loved him with infatuation. You expected a virile gospel and were not disappointed. In his palmy days he deserved the title of a great preacher. Whether he could have preserved that honor till he ceased his pulpit labors is not easily answered. Whether the last ten years of his ministry would have created more for God if he had devoted his powers to preaching, I can not say. But from that time his pulpit supremacy somewhat waned. It is not offered as an adverse criticism that he was not the same master. His genius had not failed; but when he turned aside to make lenses, the whole enthusiasm of his nature was in the new field. Preaching became second, lenses first. —Stubbs.[32]

The doubt here so gently expressed, as to whether Peate did the right thing in turning to "lens" making probably took a more vigorous form among the more narrow-minded members of the sect, and Peate's mirrors were probably accepted by their recipients with some misgiving, as the product of a great man who in his old age was showing signs of backsliding. Probably for this reason,

> I have no reliable information concerning John Peate other than his church activities. To the best of my knowledge there are no records of his work done in the realm of astronomy. Our histories simply touch on the fact that he devoted himself to these things, but give no details.
>
> Yours,
> Chas. J. Zetler, Clarendon, Pa.[38]

His physical vigor continued to a very late day. When he was seventy-eight he took E. S. Templeton and John Morrison (both of Greenville) on a hike from Buffalo to Niagara. As they ate lunch at an inn in Buffalo, their project became known, and the tavern turned out to see the start and to drink to the old man's luck. Someone expressed surprise that such an elderly man should think of walking so far.

"Well," said Peate, "I'd never have done it by drinking beer."

His companions were much younger than himself, Morrison just a young man, so all reached

[38] Private communication, Dec. 8, 1934. Dr. Zetler is Secretary of the Erie Conference at the present time.

Niagara safely enough, though footsore. They bathed their feet in brandy that night, Mr. Templeton insisting it was the best remedy. Next day Peate went swimming in the whirlpool. He knew the currents from boyhood and kept out of the danger zones.[39]

> Dr. Peate was a most delightful conversationalist. He had gathered from the four winds of the heavens, and he wove his knowledge into most charming messages. When visiting Lick Observatory, the distinguished scholars paid him respect and deference and were won by his familiarity with the heavens. They easily read that he was a child of the stars. His townsmen called him "the distinguished citizen," not more for his learning and greatness than for his simplicity and fascinating converse. He was a student. All his life he was the close, dogged student of God in nature, science, and revelation. When past middle life, he became a student of science. His library reveals that difficult and abstruse works had become his delight. When most men long since had unbuckled the harness, he was as David before Goliath, ready to tackle giant problems. From various institutions he was honored with the degrees of A.M., D.D., and L.L.D.
> —Stubbs.[32]

When about eighty years of age, he was visiting friends in Jamestown, N. Y., when he took a fancy to go to Paris, France.[40] This was probably at the time of the Paris Exposition (1900).

Without further ado he departed, with just the clothes he stood up in, and enjoyed the trip immensely. He derived great glee from the puzzled questions of his fellow travelers on the ship, for his breadth of knowledge astonished them all. They thought him a college professor, a diplomat, or something of that sort, or a great scientist. "No, no," said Peate, "I'm a bricklayer."

As an old man, he called in the carpenters to remodel part of his house. They did the carpentry all right, but there was a chimney. Peate suggested at a certain stage of the work that they had better build the chimney before they went too far.

"That's what we wanted to see you about, Dr. Peate. You had better call in the bricklayers."

"Oh, I'm a poor man, and bricklayers charge so much. We'll have to build the chimney ourselves."

"We can't do that. We're carpenters, not bricklayers."

"Well, then I'll build it," said Peate.

The carpenters expostulated; no amateur could build a brick chimney. Peate, concealing his history, to the consternation of the workmen proceeded to lay the bricks up like an expert and greatly enjoyed the joke.[40]

When past eighty, he went skating and continued this strenuous life almost to the day of his death, for he conducted a memorial or burial service less than a week before his passing,[41] and on his death bed gave complete instructions about his own burial service.

To return now to the big mirror. There were in America at this time, it was said, only three men who could figure telescope mirrors.[42] One was the well-loved John Brashear of Pittsburgh, another the bricklayer of Greenville, and the third presumably Alvan Clark of New England.[43] Peate's decision to make the largest glass telescope mirror in the world is said to have caused some coolness on the part of John Brashear.[44] The latter wrote an article in the *National Glass Budget*, early in 1895, describing telescope lenses and mirrors, the processes of making them, and the difficulties involved.[45]

In the meantime Peate began to make arrangements for a place to work and test his mirror and for the machinery to grind and polish it. He contracted with the little machine shop of John Hodge[46] at Greenville, which employed four men, for the tools and apparatus with which the epoch-making mirror was to be worked. Among the four was Frank A'Hearn, now general foreman of the Bessemer & Lake Erie Railroad Shops at Greenville, then just a boy. Mr. A'Hearn's pocket notebook in November, 1894, begins to make notes, "Work for Dr. Peate, $3\frac{1}{2}$ hours," and so on. Thus the apparatus for working the "lens" was being constructed several months before the Standard Plate attempted to see if it could really cast the mirror itself.

In a piece of cow-pasture on the east side of Greenville, Peate built a grinding shed and testing corridor.[47] The place is now built up with

[39] Information from John Morrison.
[40] Information from Frank A'Hearn.
[41] *Evening Record*, Greenville, Pa., March 24, 1903.
[42] Information from George Lambert and George E. Howard.
[43] Dr. Hostetter's guess as to the third. (J. C. Hostetter, Director of Research, Corning Glass Works, Corning, N. Y.)
[44] Information from George Lambert; but Brashear thought a lot of Peate, according to Howard.
[45] Up to date no copy of this can be found in the country. A reference to it appears in the *Advance Argus*, May 23, 1895.
[46] The Hodge Manufacturing Co., like the Standard Plate, apparently did its share of the work at cost.
[47] The writer is indebted to Mr. A'Hearn and John Hodge for the description of the buildings and grinding machine.

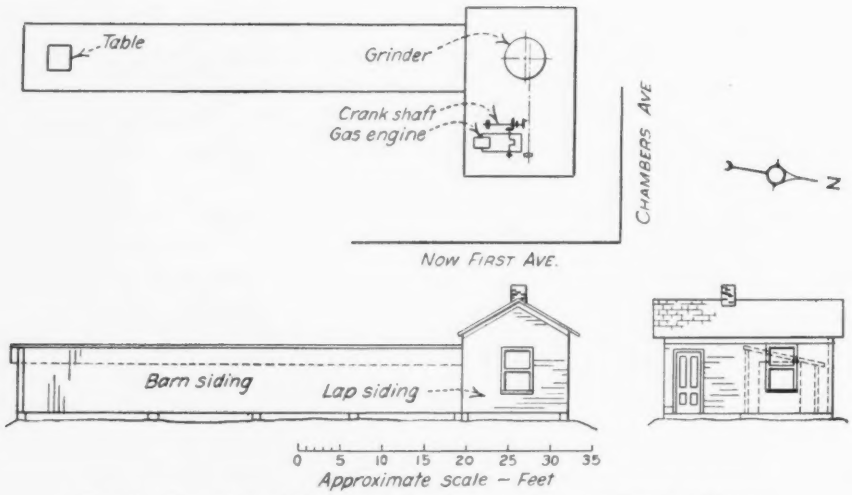
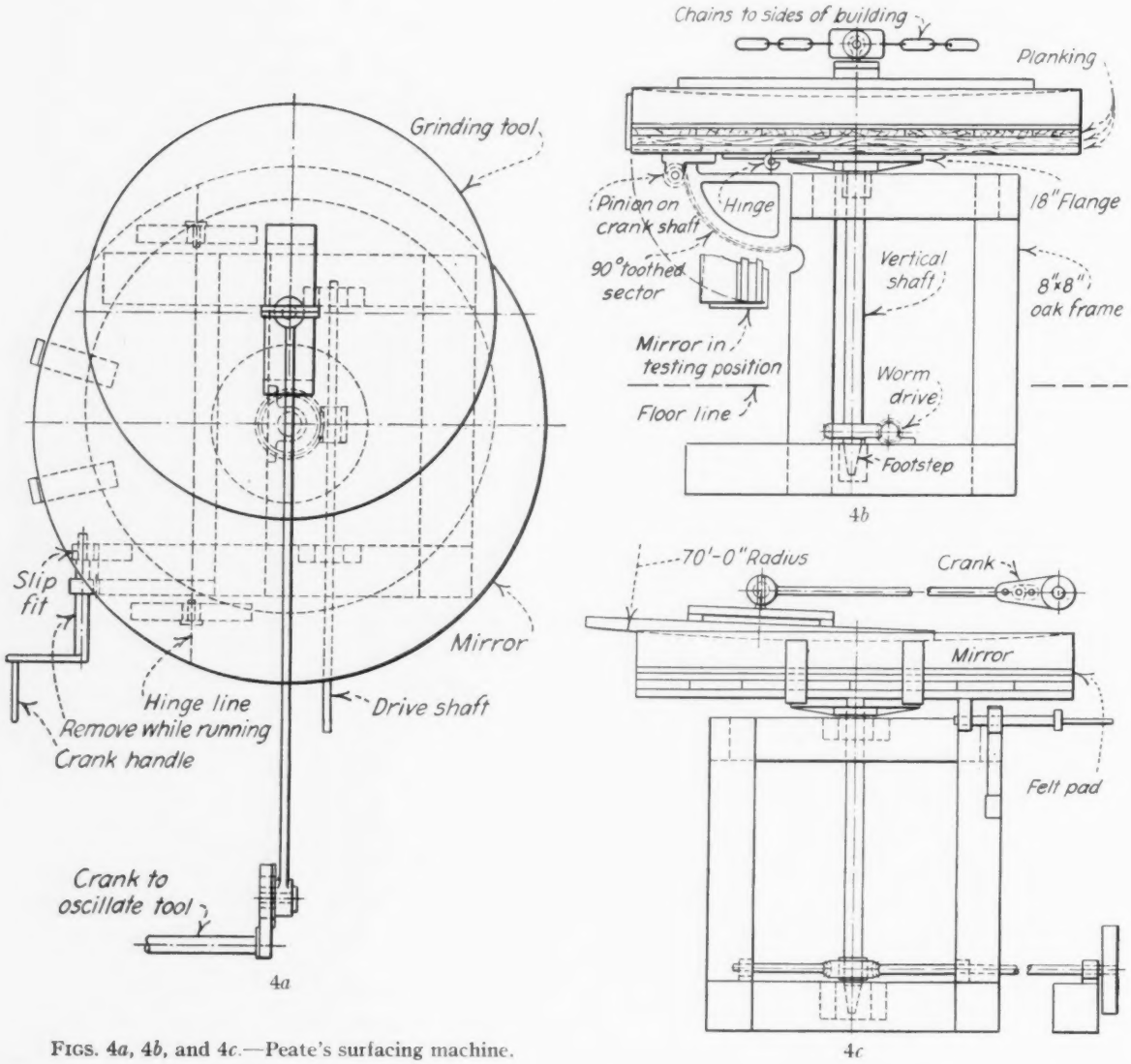


FIG. 3.—Peate's workshop at Greenville, according to Frank A'Hearn.

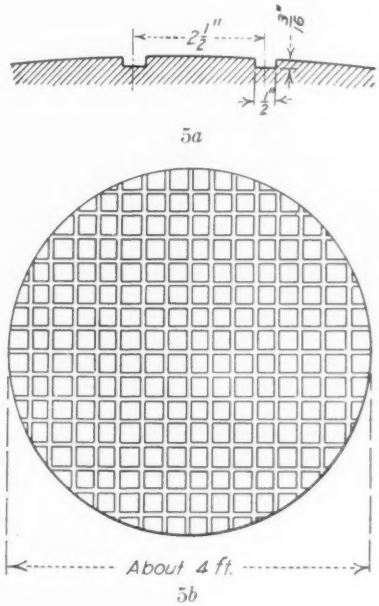


FIGS. 4*a*, 4*b*, and 4*c*.—Peate's surfacing machine.

houses, and nothing marks the historic spot.

The main shed in which the grinding was done was a place 14 by 20 feet in plan. Extending from one side of it was a long covered passageway, believed to have been 80 feet long, which was used in testing the mirror (Fig. 3).

The main framework of the grinding machine



FIGS. 5*a* and 5*b*.—The grinding and polishing "runner" or "tool."

was made of 8- by 8-inch wooden posts and crosspieces. In the center of the base was a footstep-bearing supporting a vertical shaft, which was driven through a worm gear by a little donkey engine. The shaft carried at the top a decking of 2-inch planking, on top of which was a somewhat similar second deck. The two were hinged together as shown in Fig. 4 and, by means of a crank working on a gear wheel and sector, the upper deck together with the mirror could be rotated into a vertical position for testing purposes.

For grinding the concavity Peate had several, probably three, cast-iron "tools" or runners made. One was about 12 inches in diameter and was used by hand. Another was about 30 inches in diameter, and the largest about 48 inches. The two smaller ones were smooth faced, turned to the same radius as the finished mirror had to be but convex, of course, instead of concave. The 30- and 48-inch tools were provided at the back, or top, with the male member of a ball-and-socket joint and were used by power. The 48-inch tool had grooves cut in the surface, about $^1/_2$ inch wide and $^3/_{16}$ inch deep (Fig. 5). The Hodge mechanics cut these grooves by making a pair of oak rails with a camber on them (Fig. 6). A little square buggy could run on these rails. A grinding wheel was carried from a line shaft by a radius arm and driven from a pulley on the line shaft. The buggy carried the grinding-tool casting and, as it was pushed along the oak rail, a groove was slowly cut by the grinding wheel. When a groove had been cut, the radius arm, pulleys and all, was moved $2^1/_2$ inches along the line shaft and another groove cut. When all the grooves had been cut in the one direction, the "tool" was turned 90° on the buggy, and the other set of grooves were ground to make the checker pattern. The making of this tool was undoubtedly by far the biggest job on the mechanical end of things and presumably occupied many weeks. This probably explains why the Hodge Company was busy for nearly six months before the lens was cast.

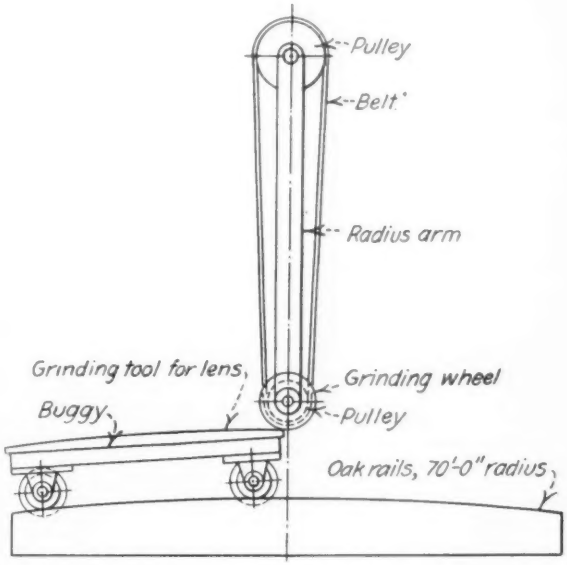


FIG. 6.—Hodge's method of cutting the checker grooves.

A connecting rod and crank, the latter with adjustable stroke (Fig. 4) was to move the grinding tool back and forth while the mirror blank revolved below it, and chains, extending from the connecting rod near its joint with the tool, went to each side wall of the shed and prevented the

tool from being carried away sidewise. With this rather primitive apparatus Dr. Peate made ready to grind and polish his "lens."[48]

Meantime, back in Butler, George Howard had not been entirely idle. He was going to use a regular plate-glass potful of glass, cast it in the usual way upon the old-fashioned traveling casting table which moved on rails in front of one kiln or another (for this was before the days of traveling lehrs), and finally have it pushed by hand into the usual kiln, whose temperature had to be judged by eye. The schedule would be settled by the kiln tender's judgment.

The only variations from the process of casting a plate of $^{7}/_{16}$-inch plate glass were that, instead of rolling the glass out flat on the table, it would be poured into a mold, 62 inches in diameter, and allowed to sit there until it cooled enough to be pushed into the kiln; a great quantity of preheated sand would be stored on the roof of the kiln and, when the disk was "stowed" and

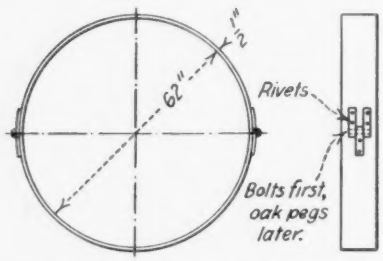


FIG. 7.—Howard's strap-iron mold for the big "lens."

adjudged to be sufficiently "set," the sand would be allowed to pour through the roof and make a mound of insulation around the disk.

For the mold, Mr. Howard prepared two semicircles of hoop iron, $^{1}/_{2}$ by 8 inches, with hinge arrangements for bolting the two halves together (Fig. 7). To avoid the introduction of bubbles in the glass, a special charcoal iron was obtained from Philadelphia. This is the same iron that was used for the "trams" or "trangs" on the regular casting table and is not apt to generate gas in contact with the molten glass. But, to avoid possible trouble from the grease on the casting table, a piece of sheet zinc was placed on the under side of the mold. Naturally, when the hot glass was poured on it, the zinc melted, volatilized, and came up through the glass in a great "boil." The cast was, of course, a complete failure.

A little later, a second attempt was made. The zinc was omitted, and a layer of sand spread thinly on the table, as is still the custom (1934) in casting plate glass by the old-fashioned method in certain plants.

This time the disk was successfully stowed by hand in the kiln and the sand dropped on it. It

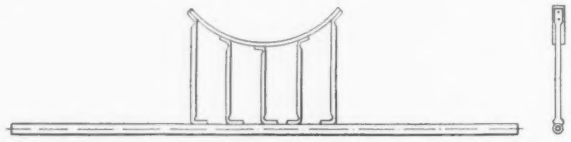


FIG. 8.—Stowing tool for pushing lens and mold into annealing kiln.

was cooled off apparently in either four or eleven days, or not much longer than was taken by a plate of $^{1}/_{2}$-inch glass. When it was taken out, it was found shattered into a thousand pieces.

The sand, let down through the roof, had made a great hollow in the top—it had been allowed to fall on the glass before the latter was sufficiently set. But the main trouble came from the mold. The bolts holding the two sections together were bent; the rivets holding the latch pieces were nearly pulled out. Evidently the mold had become very hot by the time the glass was set and then had contracted tightly round the glass, pulling itself to pieces and breaking the disk to pieces.

The *National Glass Budget* was jubilant. In stinging editorials it decried the ill-advised efforts of the Butler "bumpkins" and set forth very vigorously the opinion that the thing could not be accomplished in the United States, when the best brains of Europe found it most difficult; or at any rate, it was impossible to do it in Butler. Pittsburgh, it decided, could do it if anyone could.

Criticism and caustic comments came in from

[48] It is the general opinion (which appears at times in print) that Peate invented his own machinery and his own methods of testing. The present writer feels uncertain that any particular credit can go to Peate for the machinery, for it seems to agree closely with comparatively ancient machinery for polishing smaller pieces of optical glass; nor is there any clear evidence that Peate ever claimed any credit for it. As for his testing apparatus, there is evidence that Peate devised several tests of his own but no evidence that they were the best tests known at that time. Unfortunately, among those still living who saw Peate make his tests, there is no one who understands optics sufficiently well for the writer to be sure of the details; and among those who do understand the subject and who claim to know what Peate did, there is none who actually saw it done and their evidence is secondhand or still more remote.

university professors at Meadville[49] and from other points of the compass, but the trade journal was simply vitriolic. The Standard Plate refused (even after the successful cast) to give out any information to the press regarding the matter one way or the other[50] and, although a couple of dozen townsfolk were present at the first, highly unsuccessful cast, this is all the publicity it received.[51]

To understand the reason for an American glass manufacturer's trade journal attacking and ridiculing the attempts of an American glass manufacturer to do something new and worth while, it is necessary to explain that just about this time a great plate-glass trust had been formed and the Standard Plate had refused to join it.[52] Some feeling was engendered during the negotiations, and the attitude of the trade journal was no doubt influenced by this.

In a sense this is rather fortunate for, except for the ill-advised partisanship of the trade journal, it might now be impossible to trace any history of the whole undertaking. It is difficult enough as it is, for no publicity was sought by the Standard Plate, neither Peate nor the Methodist-Episcopal Church sought any, and the whole thing would have passed unnoticed but for the adverse comments of the editor of the trade journal.

An article in the *National Glass Budget* by "Uncle John" (John Brashear) finally convinced Howard that he had tackled something beyond his ability. Apparently Howard did not know Brashear had written it, but he recognized it as the writing of an expert and was convinced by it; apparently the article appeared in March,[53] but was not read by Howard until the end of April. He felt that he had made a fool of himself and could not possibly succeed, but fortunately the third and successful disk was already cast and cooling in the kiln, and there was nothing to do but await taking it out.

On this cast Howard had made a few simple changes. Instead of bolting the two halves of the hoop together with iron bolts, he prepared pegs of red oak, dipped in concentrated nitric acid. By the time the glass was set, the hoop was red hot, and the pegs were burnt to charcoal. Then as the iron tried to contract, the pegs "sheared off," and no stress was thrown on the glass. This ingenious scheme worked perfectly, though it is perhaps a matter of good fortune as well as good judgment that the pegs did not give out too early in the game.

The sand falling from the roof was held back until the glass was set hard enough to bear it and, according to one account (Mr. Lambert's), the annealing time was now made eleven days.[54]

The *Butler Times* (of which up to date no copies have been discovered) naturally upheld the local project, but it necessarily had little definite information so its retaliation against the trade journal was ineffective. But the latter made the mistake of painting as simpletons not only the "crude-oil-and-buckwheat-raising people" of Butler but also the "superannuated itinerant preacher" of Greenville. With that, young John Morrison's cap was in the ring.

About the middle or end of March the *Pittsburgh Leader* quoted this paragraph from the trade journal.[55]

> That alleged largest telescopic lens in the world, which was recently cast at the Standard Plate Glass Works, Butler, Pa., and was covered with sand in an annealing oven for eleven days, has been unearthed and found to be in a dozen pieces. For one reason, at least, we do not regret this result, as it will save the dear old preacher, who proposes to rub it in shape by hand with a brick, some sand and gravel, several years of arduous and honest, though fruitless labor, oceans of sweat, and millions of backaches. On the whole, however, this going into flinders and back to cullet and batch of a lens as big as a wagon wheel is to be regretted, and as there are several manufacturers in this city who are willing to undertake the casting of a second lens and willing to guarantee its coming out of the annealing furnace whole and perfect, we herewith offer to furnish names of these experts upon application to this office. No one but a superannuated itinerant preacher would ever have thought of going to Butler County to cast a lens anyhow. Butler may be all right for crude oil, brick, mud, and buckwheat, but her reputation for successfully annealing lenses is yet to be established.

[49] *Advance Argus*, Greenville, Pa., May 9, 1895.
[50] *Commoner and Glassworker*, May 18, 1895.
[51] George Lambert.
[52] *Butler Democratic Herald*, April 12, 1895 (Butler Court House files). "The great plate glass combine was completed last week and some six or seven plants have been consolidated into one company. The only plants not in the concern are the Standard Works, of Butler, and the Pennsylvania Glass Co., of Irwin. The new company represents an output of 18,000,000 square feet a year while Butler represents 1,000,000 and the Irwin plant 700,000."
[53] As we do not have the issue of the *Budget* with this article in, we take the word of John Morrison and the *Advance Argus* that it was Brashear's.
[54] The *National Glass Budget* about April 1, 1895, said the annealing time on the second (unsuccessful) disk was 11 days, but its source of information is uncertain.
[55] Exact date uncertain, probably around May 10, 1895; from a clipping left by Henry Troutman to Frank Troutman.

Morrison, for the *Advance Argus*, immediately requested "its esteemed contemporary" to send the names of the several manufacturers willing to guarantee a whole and perfect glass. The reply received was this:

> Are you in a position to guarantee the man who does this job a compensation which will repay him for his time and trouble? If so, we will give you his name. If not, he does not care to figure in the matter.

On April 18, the *Advance Argus* replied that the Packard Hardware Co. would be financially responsible.

On April 22, 1895, the glass trade journal editor wrote to the publishers of the *Advance Argus* as follows:

> We are in receipt of yours of recent date, and in reply would respectfully refer you to Geo. A. Macbeth, the well-known glass manufacturer of this city, of the firm of Geo. A. Macbeth & Co., who can accomplish the work of casting the glass which Mr. Peate desires.

The "several manufacturers" had dwindled down to one.

Apparently Macbeth's name was given before making sure of his position, for a few days later Morrison received a letter from Macbeth, dated April 26, referring to an enquiry of "yesterday," *i.e.*, April 25, three days after the date of the above letter.

The Macbeth letter to Morrison read as follows:

> Some one was in our office yesterday asking us for estimates on making 62-in. reflector, 6 in. thick, but we are too busy to undertake this job, as considerable is involved in it, and we are satisfied that nobody in the United States could make it. It is so much glass that a special furnace and a special pot must be made and a special annealing furnace, which would run the expense into several thousand dollars, if we could go at it.

Later the name of the Phillips Semner Co. was given; Semner offered to guarantee a perfect glass within sixty days. He insisted on a "remunerative price," but all correspondence failed to elicit from him what he considered a remunerative price.

However, the fun was now really over. On May 18, the *Commoner and Glassworker* wrote,

> Ridicule from a certain quarter was cast upon the attempt of the Standard Plate Glass Company to cast the glass, but if the statements of Dr. Peate are to be relied upon, Butler County is capable of casting lenses as well as buckwheat cakes, and one prophet is mistaken.
>
> If the undertaking is so formidable, we fail to see the propriety of hurling ridicule upon a company which has pluck enough to make the attempt. It should be deserving of every encouragement, and *The Commoner and Glassworker* will be pleased to hear of further efforts in this direction, even though from time to time the glass goes back to batch.

The only intelligible explanation is, of course, that the trade paper editor was supporting the Plate Glass Trust and was trying to discourage any undertaking which would reflect credit on a company outside the Trust.

We return to George Howard, disconsolately waiting over the weekend after reading the issue of the journal that dashed all his hopes.

"Well, open the kiln: we may as well know the worst."

The sand was scraped away, and it was evident the shear pins had worked. The hoop was loose.

"Is she cracked?"

"Doesn't seem to be. Can't see any vents at all."

"Be careful now. Fetch some felts. Fetch some felts—to set her on. Be careful now. Handle her very gently. . . . "

A carrying platform was constructed, and polishing felts laid over it, and with kid gloves and extreme circumspection the precious disk was moved on to it. Out in the open, with all the sand brushed off, not a "vent" (incipient crack) or bubble or flaw of any kind could be seen. The thing was carried out to the inspection room and laid gingerly down, and the Reverend Peate was sent for in great haste.

Scarcely daring to breathe in the presence of the huge disk, whose importance and impossibility had been magnified a thousandfold by the trade journal, they led the preacher to inspect it. Peate looked at it a moment, and then said,

"Give me a hammer."

Everyone's heart went into his mouth. Grabbing a hatchet that stood handy, Peate neatly whacked off the tail or sprue which is naturally left trailing from the edge as the pot is moved away after casting its contents in the mold.

"That's no use, can't do with that," said Peate, referring to the sprue, as he finished the job like an expert, while everyone else expected the lens to "explode" any instant, as prognosticated by their detractors. Peate was no doubt thoroughly enjoying their alarm.

He pronounced the disk perfect and ordered it shipped to Greenville together with the iron hoop which he used in his subsequent operations.

On the very day that Peate pronounced the disk perfect (May 4, 1895), the trade paper, still sticking obstinately to its guns, printed the following comment,[56]

> A telegraphic special from Greenville, under date of May 1, states as follows: "One of the two glasses recently cast at Butler for the 62-inch telescope lens of Dr. Peate's telescope has been taken from the annealing furnace and gives promise of being a perfect cast. The glass is not entirely cold yet. Dr. Peate will make a critical examination of the glass this week." The above is interesting if true. Why a glass maker who understands his business sufficiently to be entrusted with the casting of so large a mirror should remove it from an annealing furnace before it is entirely cold is a conundrum. If the report is true, Dr. Peate will not need to critically examine the mirror, for it will be in fractions.

By the time, however, that this issue was in the hands of its readers, the "lens" was cold, inspected, and approved.

The newspapers in Pittsburgh and elsewhere carried the news of the great American disk—the largest in the world—and quoted the wordy combat of the glass trade journal and the *Advance Argus*. The former replied that the Butler people had not made a lens at all, but only a mirror disk, and feigned surprise that that was all the Butler people were trying to do. Furthermore, even as a mirror, it was not the largest mirror in the world, Lord Ross' in Ireland being larger (72 inches). The latter mirror, however, was of speculum metal, not glass.

An editorial in the *Butler Democratic Herald* of May 24, 1895, indicates that the battle was still going on and concludes with the following appropriate remark about its rival:

> . . . we have a feeling he has set his foot in it when he goes to poke fun at the Standard about casting the biggest lens on earth, and the end of it may be a repetition of the old saw "he who laughs last, laughs best."

It seems to have escaped the notice of the disputants, though not of Peate, that Dr. Common, an English astronomer, had already made a couple of glass mirrors five feet across. This was several years ahead of Peate's efforts to produce a mirror of substantially the same size, yet neither the detractors nor the supporters of Peate and Howard mention Dr. Common's mirror. Later investigations show that there were two mirrors of his of about this size and that they are actually in use today by Harvard University. (See Appendix II.)

It seems proper to add here that the success of Howard in casting the "lens" blank in one piece, free from bubbles, and sufficiently annealed according to plate glass standards, does not mean that the Standard Plate had at one bound proved itself the equal of Saint Gobain or that the blank was really as good as Saint Gobain's would have been. Howard himself, during acquaintance of the writer with him—that is, nearly fifteen years—has rarely mentioned the great disk and, when questioned about it, has always modestly disclaimed the knowledge that would make a perfect blank. The glass *looked* as perfect as possible, but in those days polariscopes were not used in American plate glass plants, and annealing was judged by the way the glass acted in grinding, polishing, and cutting. In this respect, the glass left nothing to be desired. Howard simply made the best glass he could with his knowledge of that time.

On June 1, 1895, the Standard Plate rendered Peate an invoice, not for $1600, but for $450, "which he was glad to pay in full."[57]

We return to the "lens," now arrived in Greenville. As cast, the disk was two inches out of round, that is, it was elliptical to that extent. Peate took his bricklayer's hammer and went around the edge trimming it to a circle. Young A'Hearn expressed a fear that the preacher might start a crack, but Peate reassured him.

"It's perfectly easy if you know how."

Although it is now known[58] that the glass is not well annealed by optical standards, it is evident that if Peate could spall pieces uniformly from the edges to trim it to a circle, the disk must be satisfactorily annealed in a mechanical sense. And it should always be remembered that a telescope mirror is made of glass, not because it is transparent, or for any *optical* property of glass, but for the purely *mechanical* reason that glass is the most permanently rigid material at our disposal.

[56] Library of the State Historical Society of Wisconsin, Madison, Wis.

[57] From a letter written Oct. 11, 1922, by George Lambert to Rev. Horace Greeley Dodds of Greenville. At this time the Standard Plate had not gone through any mergers, reorganizations, or change of control, and Lambert had been continuously with the company since the casting of the "lens." There is therefore no doubt that this information is authentic.

[58] From tests by Fecker of Pittsburgh and by Morey and Wright of the Geophysical Laboratory in the winter of 1934–35.

The old Standard Plate, and the young graduate from Cornell, now fade from the picture. Neither of them ever made a telescope disk again. The scene shifts to Greenville, where Hodge and A'Hearn, as we have seen, had been busy making the machinery for grinding and polishing the huge disk.

Having trimmed off the elliptical blank until he had a rough circle, using his hammer, Peate took Howard's iron hoops as a grinding tool for the edge. He fixed the hoop and rotated the disk, feeding steel shot[59] between them until the edge was ground to a smooth and satisfactory circle.

He now began grinding the concavity in the face. This was begun with steel shot, using the checker-pattern tool,[60] and was continued with levigated emery, which Peate prepared himself. According to Howard, the grinding of the general concavity took only a couple of days, the "dish" or sagitta (the distance by which the center was lower than the periphery) being then about $^5/_8$ in.,[61] and the shape correct to within about $^1/_{10,000}$ inch. Peate himself says,[62] "190 hours were spent in rough and fine grinding. I fine-ground the mirror six times before it suited me for polishing."

The polishing and figuring operation took two years more, though the actual hours spent on the polishing were under 700.[63] Peate says, "Worked on the mirror 750 hours, distributed over more than 300 days, to say nothing of the time spent in making polishers, cleaning up, and so forth. 560 hours were spent in polishing and figuring."[62]

> The reflector, which is 62 inches in diameter, $5^3/_4$ inches thick, and weighs 1500 pounds, is a perfectly flawless piece of glass and when fully polished (and yet unsilvered) looked like a pool of limpid spring water.
>
> The Peate reflector, for such it will undoubtedly be called, will be mounted as an equatorial in a tube something over 32 feet in length. The cost of so mounting it will run up into the thousands of dollars. Telescopes to be mounted as is this one are called Newtonian telescopes, because of the principles of interior arrangement.
>
> Dr. Peate's mammoth speculum is exceeded in size only by the metallic one in Lord Ross' famous telescope at Birr Castle, Parsonstown, Ireland, which is 6 feet in diameter. It is not in use,[64] and Dr. Peate's may be considered as the largest in the world, so far as service is concerned.[63]

For the polishing operation, Peate covered his iron tool with pitch and used rouge (iron oxide) as the abrasive.[65] This is the method in most common use today for working optical elements of precision. The long time occupied is due to the fact that polishing warms the glass and so distorts the shape. A little work must be done, then the glass allowed a long time to cool before the figure can be tested again.

The mirror has no central hole in it, but a flat mirror about 6 inches square was used[66] to reflect the image to the side of the (never constructed) telescope tube.

In various accounts, the focal length of the mirror is given as 40, 70, and 80 feet. These discrepancies arise partly from confusion, in the minds of nontechnical writers, between focal length and radius of curvature, the latter being twice the former. The mirror remains with us to give the final answer to the question, but Peate himself gives the focal length as 32 feet 6 inches.[62]

Of the laborious business of testing, as he proceeded with the figuring, Peate observes,

> This glass was cast at Butler, Pa., on the fifth trial. It was very rough and weighed over one ton. It was brought to the shop in Greenville, Pa., June 6, 1895. Work was commenced on it on the 15th of July and finished on the 15th of July, 1897. During the two years, more than 750 hours were spent on the mirror. I walked about 130 miles between the mirror and the testing table, 75 feet away, in making testing examinations. The testing table stood 75 feet from the revolving table. The over 250 tests required about 8 trips from mirror to testing table. The mirror was tested in all the ways known, in the shop and on a pin and watch dial a thousand feet distant. It was silvered and tried on the heavens in the starless region under Corvus, and under the very imperfect management of the mirror on telescopic stars, the report was as good as can be expected. The mirror has a focus of 32 feet 6 inches and will do good work if it falls into the hands of an enthusiast who knows how to mount and manage it. All there is in the glass for optical purposes has been brought out. If the glass had been more perfect, the mirror would have been better than it is.—John Peate.

[59] According to Mr. A'Hearn.

[60] According to Mr. Stone, the smaller tools were used first and the large one last. Mr. Stone is of the opinion that the largest tool was "of course" of the same diameter as the "lens" itself. Mr. A'Hearn thinks it was 4 ft., not 5 ft. The present writer, in working lenses, knows that the upper member should be smaller, at least for making spherical curves.

[61] This figure, quoted simply from memory 40 years after the event, by one who had nothing to do with the actual grinding, is exceedingly close to the calculated figure (0.6 inch).

[62] Pencil manuscript of 1898: "Notes for a Talk on Telescopes before the Wesley Club in the Delaware Avenue M. E. Church in the City of Buffalo, N. Y., July 5, 1898," at present in custody of F. W. Preston.

[63] *New York Tribune*, August 7, 1898, Section 1, p. 7, col. 4.

[64] The present writer believes the Ross mirror is now in the Science Museum, South Kensington, London

[65] According to Mr. A'Hearn.

[66] According to Mr. Howard.

Of the details of the testing, we have only imperfect information. Fecker, in conversation with the writer, says he was informed that Peate did not use the knife test, but this is second-hand information. He says that Peate used "a pin with a hole through its head" stuck on a distant fence, this being apparently the pin referred to by Peate above. Howard reports the use of a sperm candle at the center of curvature and, for entertaining visitors, Peate would pull out one of his long white whiskers and hang it on the fence nearly a quarter of a mile away. Of the sperm candle test Mr. Stone writes:[67]

> I remember Dr. Peate demonstrating to me how sensitive the surface was. After he had ground the lens to the required curvature and had started polishing it, he would tilt the lens to a position where it would catch all of the light, then ask me to place my eye at the radius point and look at the lens. If the atmospheric conditions were satisfactory, it resembled a ball of fire. He would then put his finger within a short distance of the lens. The heat of his finger would expand the glass to such an extent that the spot near his finger would stand out like a mountain on the moon.

According to Lambert, there was an apple orchard across the valley, a couple of miles away, and Peate used to demonstrate his mirror to his friends by turning it on the apples.

In a further communication, Mr. Stone[68] writes:

> After the lens had acquired the approximate degree of curvature, the finishing was done by hand. When it came to the final finishing and polishing, Dr. Peate found that he was limited with regard to the time which he could work, as he could only work when temperature and weather conditions would permit. He could not work in the winter time because there was no way of evenly heating the building in which he worked and he could not work in the middle of the day in the summer time because the temperature was too hot and the heat caused a distortion of the surface.
>
> After a good deal of fussing, he worked out two ways of testing the lens. One of them was by direct sunlight from a given spot outside of the work shop. This was not always available, however, when he wanted to work, so he finally built from the work shop, a long tunnel-like shed, and fixing a candle at the proper distance from the lens, would test the lens by the reflection from the light of the candle. By doing this he could work in the early morning and late evening when the temperature was reasonably constant and satisfactory.

When Peate's offer of September, 1893, to make the lens was known, an offer was promptly forthcoming to provide the mounting for it on the same terms as Peate was making the mirror. In the March, 1894, issue of the *University Courier*[69] appears the following paragraph:

> In our last number was a brief note that Rev. John Peate had offered to furnish to the American University the largest reflecting telescope glass in the world if the material was provided. This fell under the eye of Rev. H. G. Sedgwick, of Nashville, Tenn., who now offers to mount this telescope with driving clock, circles, finder, all complete and first class, if some one will donate the cost of material. Mr. Sedgwick has lately done this work for instruments in Queensland, Australia, and England. Where is the person who will put these gentlemen to work and secure a telescope for the University? Work on the glass should begin at once, as it requires time. The other expense might come later.

Nothing more is heard of Sedgwick's offer, and whether Sedgwick died or some other obstacle developed, we do not meet his name again. In 1897 we read that Peate has already done 750 hours of actual polishing, has devised special time-saving devices, and that "it" (the mirror) "has been, to all practical purposes, finished for the past three months."

> Dr. Peate, with his usual modesty, writes that he does not claim that it is "perfect," for "nothing human is perfect," but he thinks it a good glass, that will do good work if properly mounted and handled. It would be a noble act for some friend of the University now to provide the funds for the mounting and building the observatory. It ought to be done under Dr. Peate's direction. It will take some time to develop the plans, erect the structure, and get ready for work. The University has a better place for it than the National Observatory occupies. Who will do this?[70]

As the mirror neared completion, the *Pittsburgh Leader*, one Saturday evening late in 1896 or early in 1897,[71] devoted an illustrated two-column article to Peate and his efforts, and on or about July 15, 1897, the same newspaper announced that "Peate will today notify the faculty (of the University) that the lens is finished."

The old preacher made some tests of it "on the Milky Way," climbing up some sort of a derrick thirty or forty feet into the air to reach the focus of the great mirror, and reported that he had seen stars he had never seen before, and that probably had never been seen by human eye before. This seems to have affected him with a

[67] F. W. Stone, now of The Lake Shore Gas Co., Ashtabula, Ohio. Private communication, Dec. 18, 1934.
[68] *Loc. cit.*, Dec. 27, 1934.
[69] *University Courier*, March, 1894, p. 6.
[70] *Ibid.*, Sept., 1897, p. 6.
[71] Exact date not traced.

sense of profound humility rather than exultation. These are presumably tests connected with the Corvus tests mentioned by Peate.

He now began to devote his attention to the problem of transporting the glass safely to Washington. Transportation of these big mirrors is still a problem, and Corning Glass Works in the last year or two has had to do some thinking on the subject. In Peate's day, the transportation of a now irreplaceable piece of glass weighing nearly a ton was something new in American history. Peate was nearly seventy-eight, and the prospects of replacing the lens with a duplicate, if the first one should meet with an accident, were not so good.

Dr. L. S. Rader, pastor of the Greenville church, wrote as follows:[72]

> The great lens manufactured for the American University at Washington, D. C., by Dr. John Peate, of this place, is complete, ready for shipment. An order on the United States Express Company for the free transportation of the lens was sent to Doctor Peate by Bishop Hurst last week, but there being no office of that Company at this place, the shipment is delayed.
>
> For about three years this venerable minister and scientist has given his wonderfully preserved forces of mind and body to the perfecting of this greatest reflecting telescope lens. Although he is seventy-eight years old, he recently walked twenty-seven miles at one stretch. Hundreds of people from different parts of the country visit the Doctor to see the great glass, and look at the heavens through his mounted telescope. He seems never to tire of explaining the mysteries of the wonderful "added eye." He will accompany the lens to Washington and see that it is safely delivered to the Chancellor of the American University. It is now in a carrying case of his own invention and construction. This consists of a box in which the glass is packed and a wheeled truck in which it is swung. It is swung on its edge by iron bands, which go round it over an iron belt which encircles it.
>
> Dr. Peate recently made a test of the great glass; by turning it toward the heavens and then perching himself on a ladder 32 feet from the face of the glass, he was able, through an eye-piece, to see stars he had never seen before. He said it was the greatest optical pleasure he had enjoyed since he began the study of astronomy and the making of lenses. He expresses himself as perfectly satisfied with the glass, and when he first realized that it was complete, and he could add nothing more to it, a strange joy thrilled him, and he bowed beside his work and thanked God that he had been spared to complete the task assigned him three years ago by Bishop Hurst.
>
> It has been purely a labor of love, as the work of Dr. Peate is entirely donated. He had to invent the machinery for handling, grinding, and polishing, as no machinery existed for handling so large a glass. A few have contributed toward this part of the work. Prominent among these is E. W. Hodge, of this place, who made the necessary castings at cost. It now remains for some public-spirited person to donate to the American University an observatory suitable for mounting this great lens so that with added vision from our great University we can begin to sweep far up the starry pathway toward the Eternal City.

[72] *University Courier*, July, 1898, p. 3.

In November, 1898, the *University Courier*[73] gave some account of Peate's life and of the safe arrival of the mirror at the University building.

> The removal of this glass required the greatest care. Transportation from Greenville to Washington had in it peril. Dr. Peate devised a mode of packing which seemed to promise safety in its journey. The glass was carefully placed in a box and then swung on a wheeled truck. An iron band was made to encircle the box for strength and other bands to go around it and by these it is hung, as it were, on edge. The large mirror, thus carefully guarded against injury, was placed in the main corridor of the College of History on August 24th. Dr. Peate had come on to Washington and was on hand to unpack the glass and to learn if the glass had become injured in the transporation. It was a great joy to him, to us all, to learn that the valuable telescope mirror had reached the University without harm. Our photograph of the case enclosing the glass and, near by, of the ingenious and talented maker will be a gladly welcomed sight to the friends of the American University. Some day, we trust before long, a noble and generous giver will appear, who will provide for the proper mounting of this mirror and also build it a worthy housing.

The mirror now began its long hibernation, while the stars ticked off the passing of a whole generation. Peate lived for five years more, active and enthusiastic to the last. He traveled alone to Europe at the age of eighty to attend the Paris Exposition of that year, and amused himself by defying his fellow passengers to guess his business. In the *Courier* for April, 1903, is a brief mention of Peate's death and another hopeless appeal for funds to mount the telescope.[74]

> Some friend of Dr. Peate's ought to have the lens appropriately mounted and fitted for actual use. No more fitting memorial could be given the dead hero. Will some friend do it?"

And again in the October, 1903, issue of the *Courier* is a longer obituary notice, full of inaccuracies, but still repeating, "Some generous friend should have the lens mounted and let it do its work."

After Peate's death, but still in 1903, the *University Courier*[75] reports,

[73] *University Courier*, Nov., 1898, p. 5.

[74] *Ibid.*, April, 1903, p. 6.

[75] From a clipping supplied by Miss Minnie Peate (John Peate's daughter), La Jolla, Calif., with private communication dated Feb. 8, 1935.

The glad news comes that a gentleman in Pennsylvania, who does not desire his name made public at present, will contribute a building costing $100,000 to the American University. He proposes an observatory with all modern appliances which will include the full mounting of Dr. John Peate's great lens mentioned in another column.

Up to date I have not ascertained who made this offer and why it was never carried out.

The University's appeal does not seem to have been pressed with any real vigor, and the Erie Conference seems to have had the gravest misgivings about the propriety of a preacher taking up telescope making. From our point of view today, Peate was very unfortunate in his affiliations, the lukewarmness of the University, and the coldness, amounting to hostility, on the part of the Conference, making failure certain.

In 1922 a movement was started at Greenville to enquire what was being done after all these years with Peate's masterpiece. At this time the Rev. H. G. Dodds was preacher at Greenville, and the Greenville Round Table (founded by Peate, I believe) voted $90 for his expenses to see if the mirror could not be used. At the annual meeting of the Erie Conference in that year, Bishop Homer G. Sturtz appointed Dodds a committee of one to find out what had happened to the mirror, and the Hodge Manufacturing Company defrayed the cost of printing his report.[76] The attitude of the Conference is well shown by the following paragraph,[77] which is *all* that is said on the subject except for Dodds' report, and this latter, as we have said, was paid for by the Hodge Manufacturing Company.

H. G. Dodds presented the report of the Committee appointed at our session a year ago, he being the Committee, on the reflecting telescope lens made by Dr. John Peate for the American University, and on his motion the report was adopted with the provision that the adoption carries with it no assumption of financial obligation. He was continued as the committeeman on this subject.

This issue of the Journal is 220 pages long, yet all the space that can be spared, at the Conference's expense, for Dodds and Peate is one short paragraph. On pages 787 and 788 of the same issue is a "memorial" in the form of a lamentation regretting the poverty of the church's theological schools and the sad effect this must have, since "not only the future of the church but the hope of a Christian civilization for America and the world is dependent upon a trained spiritual leadership."

It is a curious commentary on the blindness of the church that it does not see that the greatest inspiration for young men will not come from pettifogging courses in theological institutions, but from the example of great men and great enterprises tackled on the most limited resources. With such an asset in their pockets as Peate's accomplishments as a preacher and his remarkable achievements in his old age as a telescope maker, they prefer to hear nothing of his memory, to avoid capitalizing on his work, and to go around lamenting a lack of leadership.

From Dodds' report we omit the parts dealing with the early history of the mirror, and begin with January, 1923.

About the middle of January last he (Dodds) went to Washington, D. C., in the performance of this work. He met Chancellor Emeritus Bishop J. W. Hamilton and Chancellor Lucius C. Clark of the University and together they drove to the building in which the glass is kept. We found that it had not been removed from the box in which it was shipped by Dr. Peate almost three decades ago. It was standing on its edge and within about sixteen feet of a radiator for giving artificial heat to the building. We could find no indication that misfortune had befallen it in bringing it to its present position.

Some ten days or two weeks after this visit to Washington, D. C., we made a visit to Cleveland, Ohio, to the firm of Warner and Swazie, of that place, who are engaged in the business of mounting telescopes, to ascertain the approximate cost of erecting a suitable building upon the university grounds and mounting ready for use this wonderful piece of mechanism which had remained so long in obscurity.

We failed to get the information that we sought, but found instead a prejudice against the reflector made by Dr. Peate. This prejudice came partly from the fact that Dr. Peate was not a finished scientist in this realm of work and partly from the fact that the glass had stood for almost thirty years in the one position and the assumption that an attempt would have been made to mount it long ago had it not been known to be worthless.

We then made three recommendations or suggestions to Chancellor Clark, which grew partly out of our talk with the Cleveland people. We suggested 1st, that the glass be turned one-half over to avoid the tendency of the molecules to pour toward the lowest point of the mirror; 2nd, that care be taken that the mirror be not unequally heated on its two sides or that it be kept in a room not artificially heated; and 3rd, that an examination of the glass be made by experts from the Bureau of Standards in Weights and Measures, of Washington, D. C., and that their report should be obtained. All these recommendations and suggestions have received due attention.

We beg to report also that the failure to mount the re-

[76] Journal and Year Book of the Erie Conference for 1923, pp. 791–94.
[77] Page 732.

flector in the past is due largely to the fact that the University was without the funds for that purpose that would warrant them in proceeding to do this work. We find that the right of ownership in no sense inheres in the Erie Conference, but instead the glass is wholly the property of the American University. We beg to report further that when this glass was first made it was the largest of its kind in the world. If we mean by this that it is the largest concave mirror in the world, it would not be entitled to that distinction, as a concave lens seventy-two inches in diameter is now in service at Victoria on the island of Vancouver. And another, one hundred and one inches in diameter and thirteen inches thick is in process of construction on Mount Wilson near Pasadena, California. But this glass has the distinction of being a parabalo in form rather than concave. This distinction adds to its power and belongs to this glass alone as far as we are able to find. This glass also bears the distinction of being moulded without an air bubble in it. This is a rare distinction which belongs, we believe, to no other glass in the world.

The ground for belief that this glass is worthless is not sufficient to warrant its being abandoned. Its critics say that it is too thin without knowing how thick it is. They also say that it should be abandoned because of the lapse of time between its completion and the present, but failed to name any weakness or defect that has developed on this account.

We suggest that further testing of its perfections be made by the Bureau of Standards—that the glass be taken from the crate and so placed as to again give a reflection. If this proves to be perfect then we should join the University in mounting it and putting it into service.

The Greenville Round Table paid me ninety dollars to be applied on my expense account, and the Hodge Manufacturing Co. will pay the cost of printing this report. We beg to suggest that some one be appointed by the Conference or University to make honorable settlement with any who may have claims for work done or service rendered and which claims may still be unadjusted.

We recommend that the glass be under the care of someone who is alive to the care that it requires for its well-being.

Reflections have been made from this glass of wonderful perfections, one of which required the construction of a derrick of sufficient height to put the observer at the focus of the reflector for a glimpse at the "Milky Way." When Dr. Peate, who was the first to make this observation, had taken this view of the heavens he descended from the derrick and knelt by the glass and thanked God for permitting him to see worlds that no human eye had ever seen before, but, said he to the writer, while this glass was able to resolve the "star dust" of the "Milky Way" into separate stars there was still a "Milky Way" beyond.

Dr. C. B. Wakefield, pastor of the Presbyterian church, Greenville, relates to the writer that Dr. Peate had told him that with the use of this glass he could volatilize diamond. This indicates something of the power of the lens when dealing with the full ray from the sun.[78]

From this report it will be apparent that Dr. Dodds, though diligent in following up Peate's work, had not gone to any trouble to familiarize himself with even the most elementary optics and could not talk the language of astronomers or opticians. The hesitancy of Warner and Swazie may indeed have arisen less from Peate's supposed amateurishness than from Dodds' lack of familiarity with the technical aspects of the problem. However that may be, the report certainly leaves the impression that Dodds was right in arguing that people seemed suspicious of the mirror rather than confident that it was in fact faulty.

At about the same time, Perkins Observatory (Ohio Wesleyan University), decided to investigate the possibility of using Peate's mirror. Dr. Crump of that University, J. W. Fecker of Pittsburgh (successor to John Brashear and J. B. McDowell), and A. N. Finn and A. Q. Tool of the Bureau of Standards went to Washington to inspect the glass. They found it remarkably free from bubbles and similar defects, and (as no comment is made to the contrary) presumably well polished; but the figure was not tested for lack of facilities, and the glass was found badly strained (from poor annealing). According to one report there was a crack entering the glass from the central aperture, but the objection to this is that the glass has no central aperture.

Mr. Fecker advised against using the glass unless it be first re-annealed carefully. If re-annealed, it would no doubt require a certain amount of refiguring, even if the present figure is good. If re-annealed and refigured, it would still be a rather thin and flexible "lens," so perhaps the best thing was to get a new mirror. It was this decision that resulted in the Bureau of Standards making its big mirror in or about 1928, a mirror now in use at Perkins. With the exception of the 40-inch mirror cast at Spencer Lens Company by Sharp and Rising, the Bureau's mirror was the first telescope mirror of any size to be cast in America since the Butler (Peate) mirror—an interval of over 30 years.

An interval of a few years more brings us to the attempted fused silica mirrors of the General Electric Company and the ribbed borosilicate mirrors of Corning. But at this moment (February, 1935) America has not yet ground and polished, from an American glass blank, the largest glass mirror in the world, except when Peate did it. Larger "lenses" have been cast

[78] *Loc. cit.*, pp. 792–94.

since Peate's time by Europeans, and polished in America; Corning has now *cast* larger disks than the European. But until the Corning mirrors are polished, Peate's remains the only world record held by America.

Within the last year or eighteen months, Doctors Wright and Morey of the Geophysical Laboratory, Washington, have reported on the amount and distribution of strain in the disk. The "lens" is under considerable and asymmetric strain, as reported previously by Fecker and others. This will affect the quality of images reflected from it at any time the temperature is changing. We do not have a report upon the "figure" of the mirror at constant temperature.

The present writer inspected the mirror for visible defects about the beginning of 1935. The polish is fair, but "sleeks" and "cuts" are numerous on the concave face. There is a "vent" near the periphery, a trace of "skim" from the ladling, and a few bubbles. On the whole, the mirror blank appears very creditable for 1895, and Peate evidently knew of its limitations.

The coming of the new type ribbed, borosilicate mirrors will presumably render all solid-disk, soda-lime mirrors obsolete; we may expect them all to repose shortly in museums, alongside Peate's heroic effort. At this moment (January, 1936) it seems possible that the Howard-Peate disk though not good enough for modern visual or photographic work, could be used quite well for photoelectric and radiometric work, just as Dr. Common's mirrors are used by Harvard today.

APPENDIX I: PEATE'S OTHER "LENSES"

The oblivion that fell for a generation and more on Peate's great reflector prompts an inquiry as to the fate of Peate's other lenses and mirrors.

The newspapers of the eighteen-nineties state that Peate had already made thirteen reflectors, which were in *use* all over the world. Those few mirrors we have traced, however, have never been used, and apparently never unpacked. In the words of Morrison, "It seems as though none of the people to whom Peate presented his mirrors ever made the slightest use of them." We can not really say that this is the case until we have traced more of the mirrors; but apparently some of the colleges have forgotten that Peate ever made their mirrors, and they have certainly no idea of the date. One college is under the impression that it "declined" the 62-inch mirror which was then given to Washington.

To those of us who feel properly impressed with the work involved in making even a 10- or 15-inch mirror, it may seem that Peate was casting his pearls before unappreciative quadrupeds, but to the recipients, it probably appeared that Peate was presenting them with white elephants.

The mirror is the most vital and difficult part of a big telescope, but the mounting of even a 10-inch mirror is a job for a first-rate mechanic. It is not by any means a cheap undertaking and, if Peate hoped to see his mirrors used, it would be necessary to mount them before presenting them to the various colleges.

Then again, the use of a sizable telescope is not a job for rank amateurs. Even a 10-inch telescope is very definitely in the professional class, and to have his telescopes properly used would involve endowing a chair of astronomy along with the presentation of the mirrors. It is therefore not surprising that, as Peate was making mirrors as a hobby and not to order as a business proposition, he found no one to use them.

Referring to the Methodist-Episcopal ministry, Peate himself observed:[79]

> More than 95% of all those who join our ranks as traveling preachers are very commonplace men, with a very imperfect education, with but few books, and no real love for study or investigation. When I joined the Conference in 1849, we had on our list 143 names in all and only two of them had received a college education.

Peate is not here thinking of any lack of astronomical enthusiasm, but of the efficiency of Gospel preaching; and we can readily understand that, under such circumstances, disposing of a dozen high-power astronomical telescope mirrors to Methodist-Episcopal and other small colleges would be about as useful as presenting treatises on relativity to central African blacks. It is no disparagement of the colleges (or of the blacks) to say that they were quite unfitted for such high-brow gifts.

With a view to tracing some of them, an appeal for information was broadcast by the Editor of *Nature* in January, 1935. Up to date no information has been received. According to Mr. Fecker,

[79] History of Erie Conference, Vol. 2, p 208.

there is a considerable number of telescope mirrors lying unused up and down the country, and their makers are rarely known. Some of them are almost a hundred years old, and no doubt among those some fifty years of age, several at least are Peate's.

The telescope that Peate used at Greenville in his own private observatory seems to have gone to the Hoyt Observatory, Salina, Kansas. W. F. Hoyt was formerly principal of the Greenville high school and apparently on moving to Salina, he interested the students in astronomy. They raised funds to establish a small observatory there, and Peate's private telescope was obtained for it.

According to the *Record Argus* of Greenville[80] Peate made his first "lens" in 1870. This places Peate's glassworking activities considerably earlier than any other record. "He traded this when finished for a one-horse power engine and afterward gave the engine to a boy. The second lens was 7 inches in diameter and when finished was sent to missionaries in India where it was mounted by the British government and is still doing satisfactory work." (This is the lens which the *University Courier* says is 8 inches in diameter.)

The third is said to have been made of *flint* glass cast in Pittsburgh.[80] After doing service at Jamestown and Chautauqua, it was brought to Greenville and used by Peate in his private observatory. From there it went to Kansas, as above described. Whether it is still there is not known, but Mr. Fecker informed the writer that he had a flint-glass mirror to resilver not so long ago.

Stubbs, in his obituary notice of Peate,[81] says that one of Peate's best mirrors is at Harriman University, Tennessee. A letter to Harriman, however, has been returned by the Post Office with the notation "Out of Business." Up to date, the writer has not discovered what happened to the telescope, or the telescope mirror, there. Miss Peate thinks this was a 12-inch mirror. Chancellor Spence of Harriman spent a day at Peate's house negotiating for this mirror, and Harriman University later conferred an L.L.D. degree on Peate as a result.[82]

We assume, perhaps incorrectly, that the 15-inch mirror at Allegheny College, Meadville, Pa., is one of Peate's.

Thiel College, Greenville, Pa., has a 22-inch mirror which is definitely Peate's.

Peate's last mirror but one was over 30 inches in diameter. Miss Peate believes it to be 36 inches, and remembers how it nearly came to grief in the polishing.

There are other references to mirrors of $30^1/_2$ and 32 inches. Whether these were in fact other large mirrors or whether these and the 36-inch mirror are all versions of the same mirror, we can not at present say, but in any case there ought to be around somewhere a Peate mirror, of Saint Gobain glass probably, between 30 and 36 inches in diameter, and there may be more than one.

According to Mr. Fecker, there are a good many homeless mirrors about the country, and in most cases their history is unknown and the maker unidentified.

[80] Dec. 17, 1903. Clipping from Miss Minnie Peate, La Jolla, Calif.

[81] Minutes of Erie Conference, 1903, p. 92.

[82] Miss Minnie Peate, private communication.

APPENDIX II: DR. COMMON'S MIRRORS

These concern us only indirectly. The claim advanced on behalf of Peate that he had made the largest glass mirror in the world at the time is almost disallowed by reason of Dr. Common having made in England, a few years earlier, two mirrors which, if they are actually smaller than Peate's, are smaller by only an inch or so.

Dr. Common died in the same year as Peate (1903)[83] and made his mirrors a few years earlier than Peate (1886–1891).

A full account of Common's work appears in Memoirs of the Royal Astronomical Society, Vol. I.[83]

An obituary notice of Dr. Common was published.[84] A condensed statement of the years of manufacture comes from Dr. Bay of the John Crerar Library.

The work of making the disc of glass into a mirror was begun in 1886, but miscarried. A new disc was ordered from Paris in 1888, delivered in 1890, and ground and

[83] Private communication from Harlow Shapley, Feb. 8, 1935.

[84] *Monthly Notices of the Royal Astronomical Soc.*, **64**, 274 ff. (1903).

polished in 1891. Meanwhile the first disc was reground and gone over, and subsequently used.

Dr. Common did a little photographic work with these mirrors in England, but his mountings were poor and his results not very good. The glass is very thin. Both mirrors were later purchased by Harvard University: one was refigured by Mr. Fecker who reports that the glass was very badly over-corrected (the edge ground away too much): the other was not refigured. The polishing of the surface was not too good.

We give below Dr. Shapley's report from Harvard College Observatory.[85]

One of the two mirrors made by Dr. Common, and later purchased by the Harvard Observatory, was refigured a few years ago and is now in use in the 60-inch reflector on Harvard Kopje in Bloemfontein, Orange Free State, South Africa. The other was lent some years ago to the Perkins Observatory, Delaware, Ohio, later returned to Harvard, and is now in use (without being refigured) in the 61-inch reflector of the Observatory at Oak Ridge, twenty-five miles northwest of Cambridge. Both of them are about five inches in thickness, instead of the usual seven or eight inches. The glass, I believe, was made at the Saint Gobain Works in France in the late 1880's. One has a hole in the center and can be used in the Cassegrain as well as in the Newtonian arrangement. The other is without hole (the one in South Africa).

Dr. Common used one of these two mirrors—we have never been able to be sure which one—in some early experimental work at his observatory in England. But his mountings were very crude, compared with modern American mountings, and his work was not very satisfactory. A few plates made by him are in the possession of the Royal Astronomical Society in London.

Both of these Common mirrors will be replaced within the next few years by thicker mirrors of Pyrex-brand glass. One of the blanks has already been made and is in the process of annealing at Corning, New York. The other has also been cast, but is stored for some months before annealing is taken up. After the installations, some years hence, of the Pyrex-brand mirrors in the two large mountings, at least one of the Common mirrors will continue to be used systematically in photoelectric photometry, for which it is very satisfactorily adaptable.

Dr. Common finished neither of these mirrors to the perfection that we now make large reflectors. Both pieces of glass apparently were of very fine quality. There are some advantages in the thinness of the mirrors—lightness, quicker temperature adjustments, etc.—but some disadvantages, such as the bending under strain if not very carefully floated.

[85] Private communication, Jan. 29, 1935.

APPENDIX III: THE EFFECT OF STRAIN IN THE GLASS ON REFLECTING TELESCOPE IMAGES

Peate's mirror was not mounted at the time it was made simply from lack of funds. This state of affairs continued until about 1923, when Dodds began his investigations. Then for the first time we hear of technical objections but of a very nebulous character. The only objection the present writer heard of at that time was that the glass was too thin and that flexure under its own weight would distort it. The question was raised, however, as to whether the glass would have flowed under its own weight—the notion that glass is a viscous liquid was current even in those days—and Peate had swung the thing on trunions so that the top could be turned to the bottom at intervals. This viscous flow is a mythical business, but a very very slight elastic after-working has been noticed at times, though it is quite unimportant.[86]

The accuracy of Peate's figuring has never been tested up to 1935, so that the "lens" never went unmounted on that score, though the figuring may not be good by present standards.

The annealing of the blank was investigated by Mr. Fecker some ten years ago. The glass showed considerable strain (birefringence), and the strain figure was not symmetrical. This does no harm as long as the glass is at an absolutely uniform temperature, but an objective weighing a ton or thereabouts is never in complete thermal equilibrium in an observatory—the place is always getting a little warmer or a little cooler. With unstrained glass, this results in slight changes of focal length, but with unsymmetrically strained glass it produces, as a matter of experience, "astigmatism." This means that the glass behaves like an ellipsoidal bowl instead of a spherical one. The image of a star is elongated in one direction or the other, and there is no true focus.

This was the cause of the Peate mirror being declined, at Mr. Fecker's recommendation, when, in the middle 1920's, Perkins Observatory, attached to Ohio Wesleyan University, considered using it, and led to the Bureau of Standards casting a new disk for the purpose.

[86] Private communication, F. W. Fecker, Feb. 5, 1935.

EPILOGUE: A NOTE ON HISTORICAL RESEARCH

The present writer is an engineer, not a historian, and the readers for whom this account was in the first instance intended are, for the most part, technologists of one sort or another. A few comments on the peculiar features of historical research may therefore not be out of place.

The subject matter of history must be regarded as extremely simple in comparison with the subject matter of physics. The question as to whether John Peate ever went to school or college is, on the face of things, a very simple one which anybody can grasp. The question whether he paid $100, $500, or $1600 for the mirror blank is also something that any laborer can understand. These questions are quite different from the question, which taxes the ingenuity of the Geophysical Laboratory, as to what is the crystallizing sequence of an average commercial glass or the seemingly simple question as to what is its true tensile strength, which at present has us all guessing.

Yet in spite of the simplicity of the subject matter, historical research is involved in a very peculiar difficulty, which is that history is recorded in the first instance in a contemporaneous daily, weekly, or monthly press, which for the most part is entirely indifferent to the facts. "News" is news only for a few hours, and it is necessary to print something immediately. There is no time to check up on its accuracy. Successful journalism requires that the news be "red-hot," not that it be correct. Its purpose is to interest, amuse, frighten, or gratify the reader, not to instruct or educate him. Any kind of inaccuracy, up to and including a downright lie, is permissible, so long as it is not actionable in a law court.

This is unfortunate but to a great extent a natural growth. Nonetheless it does not appear to be inevitable. The vernacular press could easily weigh its statements and, when the facts were unknown, indicate what was fact and what was supposition.

There is scarcely a single point in all the foregoing account of Peate and his big mirror that is not the result of sifting out one of two or more diametrically opposing stories. In some cases these stories are verbal; they represent what people have told me in the last ten years about things that happened forty years ago. Naturally, imperfect recollection will account for many errors in such cases, but in many instances it appears more probable to me that the authors never knew the facts in the first instance. This latter explanation is necessarily the case in the errors printed in the journals and newspapers at the time: the editors never knew the facts or were confused on the meaning of terms.

In general, I have preferred contemporary printed records as likely to be more accurate than present-day recollections, but to this rule there are many exceptions, for, as mentioned above, the journalistic press is, and was, entirely indifferent to facts; and this applies even to compilations which purport to be histories and are free from the necessity of presenting news "red hot." So riddled with inaccuracy are the historical accounts, that it is impossible to believe a thing they say, and the present writer has almost reached the point of believing there is not an ounce of truth in his own account of Peate and his "lens."

A few examples may perhaps be given.

It is thoroughly attested by contemporary documents that the blank was *cast* in April, 1895, yet McKee[87] gives the date as 1898.

The *Butler Democratic Herald* says that Peate inspected his "lens" on a Friday; the *Greenville Advance Argus* places it on a Saturday.

Nearly all the accounts refer to the mirror as a "lens," which may be allowed to pass, as it serves the purpose of one; but the *Butler Democratic Herald*, with a fine (but apparently unconscious) sense of humor, describes it as "a *microscopic* lens."[88]

The *University Courier*[89] for October, 1903, says, "Until in his seventy-fifth year, he (Peate) had absolutely no technical knowledge of the laws of optics, nor any practical experience in the making of lenses." Peate's seventy-fifth year would be 1895. But the same journal[90] in 1895 says, "The Doctor is not a novice at this business (grinding telescope lenses) but has been at it for sixteen years."

The price of the mirror is variously given by Lambert as $100, by the *Argus* (in print) as $500,

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[87] Twentieth Century History of Butler and Butler County. Richard-Arnold Publishing Co., Chicago, 1909, p. 427.

[88] Issue of May 10, 1895, p. 1.

[89] *University Courier*, **10** [3] 1 (Oct., 1903).

[90] *Ibid.*, **3** [4] 5 (June, 1895).

and by Howard as $1600. In this case, the last estimate is well attested as the quotation, but the price actually charged was $450, agreeing roughly with the *Argus* figure. Morrison usually knew what he was talking about. One account says that Saint Gobain stood prepared to make a similar blank for $500; another, that they quoted $18,000. Again I prefer the recollection to the printed account, and Lambert's letter of 1922 confirms the Butler recollections of 1934.

The inaccuracies of the vernacular press are matched by the ecclesiastical documents. The histories and obituary notices of the Methodist-Episcopal church make very strange reading, for they are much more concerned to magnify the Lord than to tell the truth and shame the devil. An outsider gets the impression that the Lord is somewhat microscopic and needs a lot of magnifying.

Thus R. N. Stubbs in his obituary notice of Peate says, "He taught the glass-men to make the casting." Peate certainly could never have made such a claim, and Stubbs is drawing on his imagination, carried away by the fervor of his subject. (The preceding sentence is, "This man had faith," and probably the appearance of the last little word from Stubbs' pen was too much for his evangelical mind and carried him completely away.) Anyhow Peate hadn't a thing to do with the casting process and didn't teach the glass-men anything about this phase of the operation.

Stubbs also says that Peate was nine when he left Ireland for Canada, though Fradenburgh with greater detail makes him seven. Stubbs says he married at 25 (in 1845) which agrees with Borland's obituary notice of Mrs. Peate,[91] but Fradenburgh makes it 1848, while the *University Courier*[89] says, "Dr. Peate's parents came to American from Ireland when he was twelve years old." The same journal[92] says he was born in County Cavan, Ulster, while Fradenburgh's account makes it County Monaghon, Northern Ireland.[93]

Stubbs waxes eloquent in one lurid paragraph:

> The glass some day will reveal depths of the universe which will be as though God spoke from his inmost soul. What secrets will it reveal! What stars unknown will shine! What systems will wheel into vision! What problems it will help to solve! Are we on the borders or in the center of creation? Is man the sole heir of the universe? It is like an eye of God turned into the depths of His own heart.

The last sentence may be regarded as gruesome or blasphemous according to the point of view; it certainly is not poetic. And the rest of the pleasant intoxication wakes in the cold gray dawn of 1934 to find Peate's masterpiece still in its original packing case, unturned, and all but unnoticed since Peate finished it more than a generation ago.

In the *University Courier*,[92] we read that Peate has completed sixteen mirrors since he became interested in the subject, though elsewhere the number is given as 14 (including the 62-inch mirror). This may possibly be reconciled through Mr. Stone's comment[94] that Peate made a 3-inch and a 6-inch *refractor* before taking up mirror-making, so that two refractors and fourteen mirrors make a total of sixteen objectives.

According to one account, "the Bishop" started Peate in the business of mirror-making. According to John Morrison's obituary notice of Peate, it was Dr. Wyeth. This is a misprint for Wythe. The Morrison account of 1903 is almost certainly correct, as the following paragraph from the History of the Erie Conference[95] shows:

> Dr. Wythe was a microscopist of no mean abilities. He could grind his own lenses, if need be. It was he who inspired John Peate to his daring feat of grinding the greatest lens in the world. At one time he made a parabola to throw a side light upon the object of investigation. Mechanics was familiar to him. If he had been placed in any railroad shop he would have been a fortune to the company. He was undoubtedly the peer of master minds in that profession. A draftsman, too, he was, of rare skill. He often assayed the inventor's realm, and had what often befell the flight of such geniuses—broken wings; the fruit of his industries others often gathered. He invented a prism for determining the true north. It was for some time used on the United States theodolites. He also invented an instrument for determining the speed of railroad trains. It was in use on the Erie road for many years. His last invention was the working out of an acetylene retort. He will be remembered by the countless thousands who visit Chautauqua for the Palestine and Jerusalem models, and for his work in the Hall of Antiquities. His Palestine was executed with mathematical accuracy.

The thickness of the disk is variously given as 7 inches, nearly 7 inches, 6 inches, and $5^1/_2$ inches:

[91] Minutes of Erie Conference, 1907, 117.
[92] *University Courier*, **7** [1] 4 (Nov., 1898).
[93] Neither Monaghon nor Cavan is in the present Ulster, but in the Irish Free State.
[94] Private communication from F. W. Stone, Dec. 18, 1934.
[95] J. N. Fradenburgh, Vol. II, p. 476; see also Stubbs, footnote 91.

but here some allowance must be made for its change of thickness in Peate's grinding operations. The weight is given as 2300 and as 1500 pounds. Probably the first is the blank weight and the last the finished weight after Peate had trimmed up the periphery and ground the concavity. The focal length is variously given as 40, 70, and 80 feet. This is due to confusion between radius of curvature and focal length, the former being twice the latter. The mirror itself can answer this question.

The number of attempts at Butler to cast the lens is variously given as two, three, four, and five. The *University Courier* is very specific on this point.[96] "Four times the glass was made by casting; four times there was failure. The fifth time was successful." There are hints in the Butler papers of 1895 that at one time two casts were made simultaneously in the hope that one of the two would be satisfactory. But this would need a second strap-iron mold, and it is scarcely likely Howard's recollection would fail to recall that. At present, the writer is disposed to believe there were only three casts and that the third was the successful one.

The annealing time is variously given as four and eleven days. The latter is probably correct. The *Butler Democratic Herald* says the glass was taken out of the oven on Tuesday, while other accounts say it was taken out one day before Peate arrived, which would make it Thursday or Friday. It would be interesting to know definitely the duration of *annealing* and the exact date of casting, but in view of all these conflicts some uncertainty persists.

[96] *University Courier*, **7** [1] 5 (Nov., 1898).

My personal opinion is that Peate inspected the lens on Friday, May 3, and returned to Greenville on May 4. That may account for the different dating of the inspection by the Butler and Greenville papers. Then, it is likely that the "lens" came out of the oven on the preceding Tuesday, April 30. Next, I think it likely that the annealing time was 11 days, which places the casting date about Friday, April 19, 1895. This agrees with the general view that it was cast just before the week-end.

Publicity

The Butler mirror was cast as quietly as possible. Nobody might ever have heard of it if it had not been for the *National Glass Budget*, which, by its denunciation of the temerity of the Standard Plate, converted a presumably simple task into an epoch-making venture. The only thing by which anyone now remembers the successful cast is the glee with which the participants turned the tables on the editor.

The date is forgotten, the circumstances of the cast are forgotten; Peate's mirror is in a museum instead of an observatory, and his memorial, after all, is an obscure grave in Forest Lawn, instead of a national telescope; the Standard Plate was sold a year or two ago at a receiver's sale to the Saint Gobain company and its associates. But in Butler and Greenville it is not forgotten that Butler cast a telescope mirror and Greenville polished it nearly forty years before the Bureau of Standards or Corning Glass Works.

BUTLER, PENNSYLVANIA

ACTIVITIES OF THE SOCIETY

EDITORIALS

PRESIDENTIAL ADDRESS*

J. M. McKinley

In these days of evangelical economics it is almost impossible to appraise the immediate past or place a reasonable estimate on the future. This is especially true in the case of scientific organizations that are dependent wholly or in large part upon voluntary services to carry on their activities. A report upon the stewardship of trustees, officers, and committees of the American Ceramic Society, or any similar organization, might resort to the recital of classified statistics or a summary of more or less unrelated actions, only to be bogged down in a mass of hopeless detail. Your officers believe that this detail eventually is made sufficiently clear in our publications; but we have yet to establish an adequate routine through which officers may interpret immediate current trends for the membership at large.

Insufficient editorial use has been made of *The Bulletin*. We were slow in reacting to depression effects. When the reaction did come, it held this Society in better shape than some others of similar type and size. It is highly probable that extreme fluctuations in our income may be avoided by keeping the membership more closely in touch with conditions.

From our peak income in 1929 there was a steady drop to 1933, when the figure stabilized roughly at 55% of the peak figure and much under the general level of the 1924–1929 period. Total pagination dropped in the 1929–1933 period to a level of about 65% of the 1929 top. These are the simple facts of the depression, but they do not portray the sacrifices in time and money made to bring about such a result or admit the necessity of acknowledgment on the part of the Society or its officers of some degree of perplexity in handling problems from day to day. We believe we are moving out of the depression period, marked by very few scars and proud of a membership and organization that did not fail in the critical years.

The Society is entering its thirty-eighth year. In retrospect, circumstances and personalities of the past lose the crisp definition that marks events and people about us in the Society today. Each year had its own working drawing, crowded with minute cross-sections. Now these drawings have faded and we have in their place an isometric projection that reveals readily the actual and vital form of the Society. No one can turn to the older volumes of the *Transactions* and *Journal* without sensing the truth of this simile, nor fail to realize the essential nature of the service that has been rendered. To carry forward this service requires of us something more vigorous than nominal thought in dealing with the matter of Society events, the people who shape them and the constantly widening field of the Society.

Our thinking must go afield—back into the past and into the future—before taking stock of the immediate things in hand. Our perspective may be, or frequently is, distorted, and it is well to remember that the character of a photographic image is governed more especially by the focal length of the lens than by any other single consideration. Let us at least not attempt to sweep up with a wide-angle lens all of the detail comprising the present daily life of the Society, and, having captured a flattened mass of light and shade, proceed to evaluate—praise or condemn, as seems fit. The Society is too complex to make this possible. It is not a business enterprise; it is not an educational institution in the common sense; it is certainly not a laboratory; it is not a fraternal organization. It borrows from all of these, creating an inspirational phase of its own. You may attempt to reduce all of these elements to the terms of a practical problem, but the curious history of the Society's development year by year would seem to prove that such a problem can not be stated in reasonable terms.

Plainly the Society has reached proportions demanding clearer perception of its make-up. We have been too prone to tear down here and build up there, and at times we have used methods sug-

*Presented at the Annual Meeting, American Ceramic Society, March 30, 1936, Columbus, Ohio (General Session).

gestive of the straight-jacket in efforts to restrain some trend or movement which at the moment seemed inappropriate.

Abundant energy has characterized the Society's growth, and our greatest concern for the future should be the husbanding of this energy. Greater simplicity of organization is indicated. Very precise and simple definitions of authority must be gotten, probably best developed through simplification of the existing clumsy and verbose Constitution. And above all the aims of the Society need restatement and emphasis.

Those of us who have lived intimately in and with the Society know pretty well the fundamental objectives of the organization; but it is a safe assertion that most of us have viewed these objectives with subjective minds. Thus we have failed in some respects to present the Society in its true and full worth to supporting business and educational groups. Thus, in addition, we have set up a public viewpoint that has constituted a serious barrier in seeking fuller membership, especially from industry. There can be no point of saturation insofar as membership numbers are concerned; the saturation is in our own minds and impulses.

It is trite indeed to speak of selling the Society; it will sell itself, and only in proportion to our vision and determination in presenting its functions as assets of tremendous value to all of the ceramic arts.

By the very nature of the Society, this presentation is a personal matter, or at best a subject that can not well leave the field of Division activities. The steady growth of the Glass Division illustrates the point. The plain possibilities of the Art Division will mature into permanent values only as the personal equation of the Art Division member is solved. This Division may have to be given a form of semi-autonomy, and it is significant that all Divisions now may have reached such a point without our sensing the fact.

If you will forgive a digression into our own dreams and experience, I may be able to present the large problem of the Society in clearer light. Petty details have their hour and place, but they must be subordinated to a sense of vision and real proportion. Broad plans should dominate the immediate future of the Society in order that it may keep pace with the rapid growth of absolute technical control in the routine of both consumer and producer engaged in these various arts. The application of theory to industry creates confusion; the practical effect is often remote from the dream, and we must be alert to sense the needed adjustment, quick to provide the working contacts which stimulate pure research and police commercial specifications.

The other day I stood on the bluff of the Mississippi at Natchez. Almost in flood stage, the river was an inspiring, perhaps ominous, sight. "What," I wondered, "were the thoughts of Bienville and Tonti when they first stood on the same spot? Could they have envisioned even a small part of the human currents that were to flow with and against the mighty stream?" My reverie was interrupted by the lanquid voice of a negro—one of two share croppers lolling on the grass.

"Bill, whar about you been keepin' that Pete mule lately?"

Bill turned over slowly. "I ain't been keepin' him. I done sold him fo' twenty dollars."

"Mah Lord, yo' didn't sell him. You done give him away. Wha' fo'?"

Bill looked pained. "Plenty of reason. The hotter it gets, the faster that mule walk. I done followed him all last summer with mah tongue hangin' out, an' I don't aim to do that again fo' no mule."

Bill was silent. I faced my picture of a great river—Bienville and Tonti beneath a cross and flag—share croppers—and a mule! As we approach the task of building a greater American Ceramic Society, we will be confronted often with equally incongruous associates. I think I did glimpse the dream of Bienville, as I now grasp the vision of the Society growing into ever-increasing usefulness and power. The share-cropper, Bill, sold the mule short. I prefer to veil the comparison, because the Society can not be sold short.

THE IMPORTANCE OF CERAMICS*

By F. C. Flint

By way of introduction to the subject, I want to quote an old German saying, "That which is constantly with us we never see."

We have around us every day the products of a great industry, and Columbus is today host to the Thirty-Eighth Annual Meeting of the American Ceramic Society,

*Francis C. Flint, President of the Society for 1936 to 1937, presented the above radio address over WOSU the Ohio State University station, on Wednesday evening April 1, during the 1936 Annual Meeting.

at which approximately one thousand engineers, scientists, technologists, and manufacturers have gathered to discuss problems in the production and development of the material which has been the hand servant of the human race for thousands of years—which has been with us so long, so quietly doing its part, that we have ceased to think of it. We call those products made by fire, from "silicates"—the ordinary sand and clay—"ceramics."

What are silicates? They are the natural rocks and clays around us. They are called silicates, because they have in them the stuff of which sand is made. For the most part they are sand or clay. It is from these lowly materials that ceramics builds up the sewer tile, which simplifies the existence of our cities, and the radio tube, which makes it possible for you to hear this talk.

We realize that miles on miles of brick pavements cover the country. They are a ceramic material. All the hundreds of thousands of tons of steel are made in furnaces lined with refractories, which are a ceramic material.

In the by-gone days of the race our kitchenware was all pottery of the crudest sort, a ceramic material. Now enamelware is ever present, not only as kitchenware, but as a necessity to sanitation in the bathroom, the refrigerator, and now, architecturally for wall construction.

But enamels are not the only ceramic products that have gone to college. The crude ancient pottery went to art school, and American chinaware is leading Europe and Asia in the development of the most outstanding design and permanence of product that we have yet had. The only reason you meet these foreign competitors is because of the low cost of labor, thirty cents a day, and an *existence*—not a *living* for the laborer.

Modern research has given the artist better materials to work with and a wider choice for the play of his imagination and training. Modern research has produced dinnerware which can be purchased in sufficient quantities for a whole family for a few dollars, yet of a quality that a few hundred years ago would have made it the prized possession of the very wealthy. This peculiar industry, with its cross between the ancient and the most modern, will show a visitor to a factory methods of operation dating back to the time of the ancient Egyptians, and right beside them, modern manufacturing methods with their straight-line flow which makes possible the economies that can produce, for example, flowerpots so cheaply that we hardly count the cost.

How almost impossible the modern home would be if we took out the radio tubes, the tableware, the drinking glasses, the mirrors, the windows, tile foundation, and the brick walls—just to mention a few of the more obvious of its ceramic elements. Back of that would be the inconvenience of trying to produce the machinery for cutting the wood and making the nails for the nonceramic house—for all these have been touched by the magic fire carried by some ceramic material on its way to our comfort and use.

Not many years ago glass tumblers were rare. Only the wealthy had them. We common people drank out of pewter; those who were better off, out of other metals, silver or gold. Only a few years ago our mothers saved jelly glasses from which to drink. Now we buy better ones in the "Five & Ten." In many tumblers that were produced for royal use, though the design may have been more intricate, the glass was not as strong and durable.

On one hand we have produced glass threads finer than the finest silk with an accuracy not possible with metal machines, and on the other hand we are grinding a 17-foot glass disk, larger than the average living room, with an accuracy of a few millionths of an inch. And the glass in both of these must be so perfect that only modern science and engineering could have made it.

The same method of manufacture makes marbles and electric-light bulbs so cheaply we buy them in the "Five & Ten."

The ceramic industry takes the cheapest of raw materials—the clay, the sand, and lime—and by the use of fire converts them into the most valuable of accurately machined products and the most artistic. It does more than any other one industry to create real wealth by the labor of men's hands.

The romance of the geography of the materials used in ceramics takes us in our search for chemicals to South America for niter; to China for tin; to the mountains of the Caucasus for manganese for the beautiful purples; then to Greenland for cryolite. In the United States alone materials are brought from Montana, California, Kentucky, Ohio, Florida, and New York. Some of these are used in small amounts for color. Others are the bulk of what is used—the clay.

These materials are brought together in one plant and with modern American ingenuity shaped and fired to go out again to these same ends of the earth—sometimes a bottle, sometimes a window pane, a plate, or a brick. It may be crowded together in a big city, like New York, or perform its duty alone on a mountain top as the astronomer's silvered mirror.

The State of Ohio has always been important in the development of ceramic products. It contains many of the necessary materials in its own hills and clay pits. The energy of its citizens has converted these piles of raw material since the early days of the State into objects of usefulness and beauty.

THIS SOCIETY, A WORTH-WHILE COÖPERATIVE ORGANIZATION

Sixty (60) persons and four (4) corporations, not members in 1935, have joined this coöperative enterprise since January 1, 1936.

Eleven more subscriptions are paid to date in 1936 than were paid on January 1.

Counting the persons who have requested deferrment of the payment of their dues (on a written contract), this Society has an increase from 1274 to 1318 or a net gain of 44 personal members this early in the year of 1936.

But—and this is a tragic fact—in spite of the four new corporations, there is a net decrease of 18 in corporation support. This means that twenty-two (22) corporations which paid at least the minimum of $25.00 last year have not re-subscribed in 1936.

Why Should Ceramic Corporations Subscribe?

(1) This Society is the sole organization in the United

States, devoted exclusively to coöperatively promoting the ceramic arts, science, and technology.

(2) This Society operates under an Ohio charter and spends its entire income in (1) promoting and publishing results of original researches, (2) abstracting the world-wide literature of interest to ceramists, (3) promoting and giving collective support to ceramic raw-material resource investigations through federal and state surveys, (4) promoting ceramic research in universities and research institutes, and (5) developing ceramic training in schools of art, science, and engineering.

(3) The extent and effectiveness of the efforts of the members are limited by financial resources made available by self-assessments and by financial support of ceramic corporations.

(4) The audited financial statement for 1935, given on page 101, the March issue of *The Bulletin*, shows that 67% of the Society's income ($24,153.32 out of $36,066.17) was expended on publications and only 32% (or $11,672.63) on promotional activities and general expenses.

(5) This Society could, if financially able, publish more papers and fuller abstracts and engage more intensively in promotional activities, but the $12.50 tax on personal members can not with justice be increased. The increase in financial support should be by corporations, each paying at least $25.00 annually.

(6) It is by coöperation and recording and publishing of scientific and technical facts that industrial progress has been made.

(7) Those industries that most intensively promote the finding and the publishing of scientific facts have enjoyed the most substantial progress. This is true of single corporations and is true of industrial groups of corporations. Competition is gaining in volume from nonceramic industries who invest in technical research.

(8) The American Ceramic Society is a profitable investment, not alone on the part of individuals but also by corporations.

(9) Each ceramic corporation in America should be investing at least $25.00 annually in this research Society; some are investing more than $25.00, in addition to maintaining several personal memberships.

(10) The American Ceramic Society is the most effective, continuing educational enterprise for those who have had formal school training and those who have come up through the school of practical experience. This is evidenced by the increasing membership support.

MEMBERSHIP STATUS

Members Paid		Deferred	Subscriptions	Monthly Sales	Total Circulation
Personal	Corporation				
December 31, 1935					
1248	187	26	488	225	2174
March 29, 1936					
1221	169	97	499	200	2186

WHAT CAN A COLLEGE EDUCATION DO FOR A MAN?*

What can a college education do for a man? It depends on two things: first, what he *is*, potentially. Education does not superimpose something on a man. It can not from external sources add to his stature or girth. It can only educe, draw out, or develop that which is already latently within him. It can make of him only something which he already is, in embryo. It can furnish only the conditions for growth, soil and fertilizer, moisture and atmosphere, light and heat; it can not furnish the seed or stock.

It depends, second, on his response to its opportunities. Given the environment and conditions, a seed *must* grow; a man *may* grow; the latter can refuse. Mere exposure for four years on a college campus guarantees nothing. In some cases, it "doesn't take."

Four Facts about College Training

Four facts are faced frankly.

1. Colleges have admitted some who have not the quantity and quality of gray matter to warrant the effort involved. This percentage grows smaller and smaller every year as better and better tests for admission are devised and higher standards are insisted upon, screening out the socialite, the chronically lazy, and the incompetent with admirable but misdirected ambition. However, some even of these groups seem to have been salvaged in the process and are lifted to heights of attainment unexpected and unpredictable. Such salvagings justify considerable patience and tolerance with the slag in the ore of admissions, and warn against too drastic or dogmatic criteria of exclusion.

2. Colleges admit some of requisite capacity who fail to respond, whose passive resistance to the influx of knowledge successfully nullifies the college's efforts on their behalf. Their pathway grows more and more thorny with the closer checks and higher standards of the universities, and their percentage shrinks rapidly with the advancing classes.

3. The college enrolment has *not* included many men

* Extract from Report of Chancellor to Board of Trustees, Syracuse University, *Syracuse Univ. Bull.*, **65** [10] 2–4 (1936).

with the necessary intellectual capacity to use profitably academic training. Many of these in the University of Hard Knocks, as a result of application, concentration, responsiveness, adaptation, and diligence, find their latent capacities educed by experience in a manner and to a degree comparable to that effected by a college course. *Some* of these are developed to even higher efficiency than *some* college men.

4. Among noncollege men are found also some of mediocre natural endowment, who, by super-diligence and concentrated effort, have lifted themselves to achievements comparable with, and sometimes surpassing, those of some college men with higher abilities who did not take advantage of their opportunities.

These four facts explain why, in the world of achievement and service, the palm goes neither to college men as such, nor to noncollege men as such.

Contrasting of the college-trained man with the noncollege-trained is a profitless pastime, but kept perenially alive by the snobbishness of some college men and the sensitiveness of some noncollege men. It is ability and application that count in either.

Of course men of ability and application without college training have gone further than men of much less ability and less application with college training, but equally, of course, will men of ability and application with the added broadening and sharpening of a college course, actually taken and assimilated, go further than these same men without such additional training.

Necessity of More Training Today

Whatever the percentages of university or non-university successes or failures in the past or even present generations, the youth of today facing the onrushing future must reckon with the value if not the necessity of a university training or its equivalent.

We are told that, in one generation from 1900 to 1935, the college-trained portion of our adult population increased fivefold, from 3 to 15%.

Native intellectual capacity was as great in 1900 as it is in 1935, even as the average number of ounces of gray matter was as great in the days of Plato as in this era of New Deals. But the knowledge to be known, the fields to be covered, the analyses and syntheses required for mastery of the bewilderingly expanded physical sciences, of the intricate mazes of social sciences, and of the unfathomed depths of mental sciences and esthetic capacities require a period of preparation much longer and more intense. The rapid distention of the boundaries of knowledge in all these fields makes us almost despair of even keeping pace.

To know as much today, in proportion to the total to be known, a man must know far more than the man of 1900.

To cope with life as successfully today as did our fathers in their day, we must be far more skilled than they.

To be relatively as good, we must be far better; to be relatively as capable, we must be far more capable.

The high school may have been ample for the average man then, but now!

The question is rapidly becoming not whether a college course is necessary for an average place in life but whether only four years above high school are sufficient to provide even the preliminary awareness, insight, and skill adequate for the average beginner in active adulthood, and the youth of discernment and determination will not be so foolhardy as to face the rapidly complexifying world of his day with anything less than the fullest possib'e training he can procure for himself.

NEW MEMBERS

Personal

BEAVER, KARL, 723 East Milwaukee Ave., Detroit, Mich.; research engineer, Ethyl Gasoline Corp.

CLEWS, FRANCIS H., Mellor Laboratories, Shelton, Stoke-on-Trent, England; research chemist.

DEAR, PAUL S., P. O. Box 205, Blacksburg, Va.; instructor in ceramic engineering, Virginia Polytechnic Institute.

FLICK, FULTON B., 1706 First National Bank Bldg., Pittsburgh, Pa.; Brown, Critchlow & Flick, patent lawyers.

HALL, BETTY, 318 Hamilton St., Evanston, Ill.; ceramic artist.

JOY, ROBERT L., 2545 Olive St., Huntington Park, Calif.; superintendent of mining, Temescal Clay Co.

KELLEY, WALTER H., Bethlehem Steel Co., Bethlehem, Pa.; refractories engineer.

STARR, MARION M., 309 N. Washington Ave., Mason City, Iowa; ceramic artist.

THOMPSON, NOEL M., 1950 W. Lane Ave., Columbus, Ohio; field engineer, Atlas Lumnite Cement Co.

Student

CLARK, C. BURTON, University of Illinois.

SHECKLER, KENNETH F., Missouri School of Mines.

MEMBERSHIP WORKERS' RECORD

Personal

R. E. Birch	1	John D. Sullivan	1
Harriett Crabb	1	J. W. Whittemore	1
William Hugill	1	Office	1
H. M. Kraner	1	**Student**	
B. S. Radcliffe	1	C. M. Dodd	1
Joe Stevens	1	C. L. Thompson	1
		Grand total	**11**

ROSTER CHANGES DURING MARCH*

Personal

BARRETT, MAURICE, 66 Norton Road, Morecambe & Heysham, England. (Leeds, England)

CIBELLA, ROSS C., Titanium Pigment Co., Inc., P. O. Box 58, South Amboy, N. J. (Cleveland, Ohio)

CROSKEY, CARL D., 437 Scharum Ave., Zanesville, Ohio. (Akron, Ohio)

JORDAN, ROY E., JR., 503 Fourth St., Ironton, Ohio. (South Orange, N. J.)

POWELL, WILLIAM R., 169 Church St., Jackson, Ohio. (Mexico, Mo.)

ROUP, ROLLAND, 4372 N. Wildwood Ave., Milwaukee, Wis. (West Chicago, Ill.)

SCHLEHR, W. RAYMOND, Lake Front Road, Linthicum, Md. (Baltimore, Md.)

* Address in parentheses is the old address.

OFFICERS OF THE AMERICAN CERAMIC SOCIETY 1936–1937

President: Francis C. Flint, Chief Chemist, Hazel-Atlas Glass Co., Zanesville, Ohio
Vice-President: Robert B. Sosman, Research Laboratory, United States Steel Corp., Kearny, N. J.
Treasurer: H. B. Henderson, H. B. Henderson Co., New Brighton, Pa.
Past-President: J. M. McKinley, North American Refractories Co., Cleveland, Ohio
Past-President: W. Keith McAfee, Universal Sanitary Mfg. Co., New Castle, Pa.

TRUSTEES OF THE INDUSTRIAL DIVISIONS*

Art: Frederick H. Rhead, Homer Laughlin China Co., Newell, W. Va. (1937)
Enamel: W. C. Lindemann, A. J. Lindemann & Hoverson Co., Milwaukee, Wis. (1937)
Glass: J. T. Littleton, Corning Glass Works, Corning, N. Y. (1938)
Materials and Equipment: G. H. Brown, Rutgers University, New Brunswick, N. J. (1939)
Refractories: C. E. Bales, Ironton Fire Brick Co., Ironton, Ohio (1937)
Structural Clay Products: J. Leo Child, Hancock Brick & Tile Co., Findlay, Ohio (1939)
Terra Cotta: J. L. Carruthers, Ohio State University, Columbus, Ohio (1939)
White Wares: P. D. Helser, General Ceramics Co., New York, N. Y. (1938)

* Date of expiration of term in parentheses.

OFFICERS OF THE FELLOWS OF THE AMERICAN CERAMIC SOCIETY 1936–1937

Dean: A. S. Watts, Ohio State University, Columbus, Ohio
Associate Dean: M. C. Booze, Chas. Taylor Sons Co., Cincinnati, Ohio
Secretary: G. H. Brown, Rutgers University, New Brunswick, N. J.

ENGLAND SENDS GREETINGS TO ANNUAL MEETING

Cablegrams were received during the Columbus Meeting from two English organizations and were read by President McKinley at the General Sessions meeting, Monday, March 30.

W. E. S. Turner, Secretary of the Society of Glass Technology, Sheffield, England, cabled to the Secretary of the Society, R. C. Purdy, "Please convey to your president and members cordial greetings and good wishes from the Society of Glass Technology for successful Annual Meeting and our hopes of welcoming a large attendance at the International Congress."

C. R. F. Threlfall of Hanley, President of The Ceramic Society, Stoke-on-Trent, sent the following message: "Trust you have had most successful Meeting. Best wishes."

INDUSTRIAL DIVISION OFFICERS, 1936–1937

Art

Chairman: L. E. Barringer, General Electric Co., Schenectady, N. Y.
Secretary: C. M. Harder, New York State College of Ceramics, Alfred, N. Y.

Enamel

Chairman: G. H. McIntyre, Ferro Enamel Corp., Cleveland, Ohio
Secretary: B. J. Sweo, National Bureau of Standards, Washington, D. C.

Glass

Chairman: J. S. Gregorius, Pittsburgh Plate Glass Co., Creighton, Pa.
Vice-Chairman: A. N. Finn, National Bureau of Standards, Washington, D. C.
Secretary: S. R. Scholes, New York State College of Ceramics, Alfred, N. Y.

Materials and Equipment

Chairman: H. B. DuBois, Consolidated Feldspar Corp., East Liverpool, Ohio
Vice-Chairnan: J. E. Eagle, Vitro Manufacturing Co., Pittsburgh, Pa.
Secretary: G. F. Metz, Hardinge Co., Inc., York, Pa.

Refractories

Chairman: R. E. Birch, Harbison-Walker Refractories Co., Pittsburgh, Pa.
Vice-Chairman: H. M. Kraner, Bethlehem Steel Co., Bethlehem, Pa.
Secretary: N. W. Taylor, Pennsylvania State College, State College, Pa.

Structural Clay Products

Chairman: J. W. Whittemore, Virginia Polytechnic Inst., Blacksburg, Va.
Vice-Chairman: D. A. Moulton, Iowa State College, Ames, Iowa
Secretary: E. C. Clemens, Cannelton Sewer Pipe Co., Cannelton, Ind.

White Wares

Chairman: S. J. McDowell, General Ceramics Co., Keasbey, N. J.
Secretary: R. F. Geller, National Bureau of Standards, Washington, D. C.

58 ABSTRACTERS
Abstract 550 Journals regularly for:
CERAMIC ABSTRACTS

FELLOWS OF AMERICAN CERAMIC SOCIETY INDUCTED DURING THIRTY-EIGHTH ANNUAL MEETING

At the conclusion of the Edward Orton, Jr., Fellow Lecture, thirty-three Fellows of the American Ceramic Society were inducted at a ceremony over which retiring President J. M. McKinley presided.

Speaking during the induction ceremony President McKinley gave the following brief address:

"We pause here for a few moments to examine the threads of life as they run through our fingers. These men and women about to become Fellows have been judged upon the basis of their contributions to the ceramic arts, and of mechanical necessity this judgment has been confined more largely to the field of the past than to the future. Having found good reason in the record of the past to confer this honor, we turn now to the future. If we consider completed achievement as the sole standard of Fellowship, the body becomes little more than an empty shell. We breathe vitality into the shell when we accept these men and women as Fellows, acknowledging their attainments, and at the same time joining them in a pledge to the future that we may not fail in our obligations to the parent Society and in our ethical and professional relations one with another."

Those who were elevated to Fellow membership are as follows:

ARNOLD, RUSSELL ELLSWORTH, Research Engineer. Robinson Clay Product Co., Dover, Ohio

BOYD, ROBERT CRAIG, Ceramic Engineer, Research Division, Standard Mfg. Co., Louisville, Ky.

BLUNT, ROYDEN ADDISON, Vice-President and General Manager, The Buck Glass Co., Baltimore, Md.

BURGESS, BLANDFORD CORNEILOUS, Manager, Tennessee Mineral Products Corp., Spruce Pine, N. C.

BIRCH, RAYMOND EMBREE, Research Engineer, Harbison-Walker Refractories Co., Pittsburgh, Pa.

CABLE, MARGARET KELLY, Assistant Professor of Ceramics, Univ. of North Dakota, Grand Forks, N. D.

CAMPBELL, ROBERT MORELL, Professor of Ceramic Technology, New York State College of Ceramics, Alfred, N. Y.

CERMAK, FRANK, Superintendent of Porcelain Plant, General Electric Co., Schenectady, N. Y.

CLARK, WILLIAM MERRITT, Glass Consultant, General Electric Co. (Incandescent Lamp Department), Cleveland, Ohio

DAVIS, HARRY EDWARD, Chief Ceramist, Federal Seaboard Terra Cotta Corp., South Amboy, N. J.

DODD, CHARLES MITCHENER, Professor of Ceramic Engineering, Missouri School of Mines and Metallurgy, Rolla, Mo.

GREGORIUS, JOSEPH SCOTT, Director, Window Glass Research Dept., Pittsburgh Plate Glass Co., Creighton, Pa.

HALL, FLEMMON PORTER, Physical Chemist, Pass & Seymour, Inc., Syracuse, N. Y.

HENRY, FRANK REA, Vice-President and Manager of Sales, Simonds Worden White Co., Dayton, Ohio

JEPPSON, GEORGE NATHANIEL, Treasurer, Vice-President in Charge of Production and Director of Norton Co., Worcester, Mass.

KINZIE, CHARLES JOSEPH, Technical Director, Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

KLEYMEYER, HENRY CHARLES, President-General Manager, Standard Brick and Tile Corp., Evansville, Ind.

KNIGHT, FRANK PERKINS, JR., Consulting Engineer, Beverly Farms, Mass.

LAPP, GROVER WILLIAM, Electrical Engineer, Lapp Insulator Co., LeRoy, N. Y.

MCCAULEY, GEORGE VEST, Physicist, Corning Glass Works, Corning, N. Y.

OVERBECK, ELIZABETH GRAY, Potter, Overbeck Pottery, Cambridge City, Ind.

OAKLEY, WALTER WECKERLE, Supervisor of Gas Producers, Fuel, Furnaces, Tanks, etc., Corning Glass Works, Corning, N. Y.

ROCHE, LOUIS CHARLES, General Factory Manager, Maryland Glass Corp., Baltimore, Md.

ROEHM, VICTOR JEROME, Ceramic Chemist, Limoges China Co. (Sebring Pottery Co.), Sebring, Ohio.

SCHURTZ, DALE DALLAS, Glass Chemist, Sharp-Schurtz Co., Lancaster, Ohio.

SHARP, DONALD ELLSWORTH, President, Bailey and Sharp Co., Inc., Hamburg, N. Y.

TONE, FRANK JEROME, President, Carborundum Co.; President Canadian Carborundum Co., Ltd., and Globar Corp., Buffalo, N. Y.

TÜRK, RICHARD HENRY, Vice-President, Porcelain Enamel & Mfg. Co., Baltimore, Md.

VAIL, JAMES GARRETT, Chemical Director, Philadelphia Quartz Co., Philadelphia, Pa.

VAN SCHOICK, EMILY CAROLINE, Assistant Editor, American Ceramic Society, Columbus, Ohio

VAUGHAN, WILLIAM HARRY, Assistant Professor of Ceramics and Director, State Engineering Expt. Station, Georgia Institute of Technology and University System of Georgia, Atlanta, Ga.

WEAVER, ROBERT AUGUSTUS, President, Ferro Enamel Corp., Cleveland, Ohio.

WHITTEMORE, JOHN WEED, Professor of Ceramic Engineering, Virginia Polytechnic Institute, Blacksburg, Va.

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LOCAL SECTION NEWS

BALTIMORE-WASHINGTON SECTION

The March meeting of the Baltimore-Washington Section of the American Ceramic Society was held March 14, at Washington, D. C. J. C. Hostetter, Director of Research and Development, Corning Glass Works, Corning, N. Y., discussed "New Developments in Glass as Engineering Material."

Slides, motion pictures, and a display of new glass products gave the audience an insight into recent advances made by the glass industry.

—G. H. SPENCER-STRONG, *Secretary-Treasurer*

CALIFORNIA SECTION

Seventy-five members of the Local Section met March 9, 1936, to hear B. F. Cake, Vice-President in Charge of Production, Gladding, McBean & Co., speak on "Dust Hazards in the Ceramic Industry."

Mr. Cake, who is Chairman of the Southern California Dust Abatement Committee, reviewed briefly the history of silicosis and then discussed the present-day problems of the ceramic industry in regard to elimination of dangerous concentrations of siliceous dust in clay plants. A discussion followed Mr. Cake's address. Robert Linton, consulting engineer, reported some recent findings during an Eastern trip and added materially to the value of the discussion.

The following officers were elected to serve during 1936:

Chairman, B. M. Burchfiel, Gladding, McBean & Co., Los Angeles
Vice-Chairman, E. L. Maxson, Los Angeles
Treasurer, A. A. Brooks
Secretary, T. S. Curtis, Curtis Industrial Research Laboratories, Huntington Park, Calif.

An unexpected treat during the evening was the appearance of Charles J. Kirk, New Castle, Pa., who entertained the Section with a few anecdotes of his early experiences in the sanitary pottery field.

Through the courtesy of one of the members of the Local Section, M. J. Raimundo, a public address system was made available. —TOM CURTIS, *Secretary*

CENTRAL OHIO SECTION

Annual Report

The officers of this Section are as follows:

Chairman, Chester R. Austin, Battelle Memorial Institute, Columbus, Ohio.
Secretary, Myril C. Shaw, Edward Orton, Jr., Ceramic Research Foundation, Columbus.
Councillor, John L. Carruthers, Dept. of Ceramic Engineering, Ohio State University, Columbus.

There are 150 active members of the Section, all of them being members of the American Ceramic Society. There are no dues. Five meetings were held in 1935 with an average attendance of 35 members and five guests. Papers of technical interest and an occasional address of general interest were presented. The paper by Robert B. Sosman on "The Why of Steel Making Refractories," and a paper by G. W. Morey of the Geophysical Laboratory, Washington, D. C., were features of the 1935 meetings.

It is planned to have more papers of general interest during 1936. —CHESTER R. AUSTIN, *Chairman*

H. E. Simpson Addresses Central Ohio Section

"Trends in Refractory Slag Tests" was the subject of an address by H. E. Simpson, Battelle Memorial Institute, at the meeting of this Section on February 3, 1936, at Battelle Memorial Institute. Following the address G. A. Bole and R. C. Purdy discussed preparations for the Thirty-Eighth Annual Meeting of the Society in Columbus. The officers for 1935 were reëlected for 1936.

Aboriginal Pottery Making Discussed

The Central Ohio Section met March 16, at the Ohio State Archeological Museum, Columbus, Ohio, to hear H. C. Shetrone, Director and Archeologist of the Museum, speak on "Aboriginal Pottery and Pottery Making."

In addition to the address further plans for the Annual Meeting of the Society were discussed.

—M. C. SHAW, *Secretary*

PITTSBURGH SECTION

The Pittsburgh Section of the American Ceramic Society met February 25, in the Fellows' Room at Mellon Institute, to hear Robert B. Sosman of the Research Laboratory of the United States Steel Corporation speak on "Pyrometric Cones and the Measurement of High Temperatures."

About ninety members were in attendance including a number of high ranking officers, both past and present, of the American Ceramic Society. This group, many of whom came from a considerable distance, represented a modern "high" in attendance and their presence constituted a tribute to the reputation of Dr. Sosman as an authority on his subject.

Pyrometric Cones and the Measurement of High Temperatures

Dr. Sosman traced the history of pyrometric cones as they evolved from simple draw trials to a means for the actual investigation of temperature conditions. Blends were skilfully developed to obtain a systematic succession of melting temperatures, and this in a day when the existence of eutectics was not fully realized.

An interesting lecture experiment performed by the speaker more than twenty years ago before a Meeting group of the American Ceramic Society was described and illustrated by means of a slide. A row of cones consisting of pure potassium nitrate at one end, pure sodium nitrate at the other, and blends of the two in between was subjected to increasing temperature in a glass-windowed

furnace. At the end of the test, the two end cones were unaffected while the intermediate ones were fused down in varying degrees, giving a striking demonstration of the existence of eutectic mixtures.

The different stages passed through by cones in reaching the melting point were discussed. These include dehydration, solid-state reactions, sintering, fusion of a "controlling eutectic," and finally bending by either viscous or plastic flow. The phenomenon of cone "freezing" was shown to be related to the fact that the liquid which forms first is not always the equilibrium liquid.

The whole field of high-temperature cones was subjected to analysis with the aid of phase-equilibrium diagrams. A logical method for improvement in the cone-series was outlined. Briefly, this consists of taking mixtures over a rather broad composition field and subjecting them to the thermal treatment represented by a controlled, continuously rising temperature curve. Each cone, as it goes down, is thus identified by its time factor. This method would serve to develop a cone series in agreement with the growing understanding of the fact that cones should be used as members of a series which measures a succession of time and temperature intervals, rather than as indicators of absolute temperature.

A point was made that, owing to physical factors, large and small cones of the same composition do not come down alike (under the same time-temperature treatment). It was suggested that changes of composition in either the big or little cones could well be made in order to secure consistent thermal information in cases where both sizes are being used.

In closing Dr. Sosman touched briefly on methods of gas pyrometry and the increasing importance of a study of gas temperature in kilns.

—DWIGHT G. BENNETT, *Secretary*

ST. LOUIS SECTION

The winter meeting of the St. Louis Local Section of the American Ceramic Society was held February 28, 1936. The officers elected for 1936 are as follows:

Chairman, J. W. Wright, Owens-Illinois Glass Co., Alton, Ill.
Vice-Chairman, J. L. Crawford, Walsh Refractories Corp., St. Louis, Mo.
Secretary, R. L. Blessing, Laclede-Christy Clay Products Co., St. Louis.
Treasurer, L. C. Hewitt, Laclede-Christy Clay Products Co.

The possibilities of inviting the American Ceramic Society to hold some future Annual Meeting in St. Louis were discussed. The following papers were then presented:

"Coal, Gas, and Oil as Fuel in the Ceramic Industry," by H. W. Weber, Laclede Stoker Co.; "New Theory of Spalling," by C. M. Dodd and R. L. Stone, Missouri School of Mines and Metallurgy; "Enameling," by F. J. Zvanut, Missouri School of Mines and Metallurgy; and "Insulating Refractories," by H. E. Johnson, Laclede-Christy Clay Products Co. —R. L. BLESSING, *Secretary*

STUDENT BRANCH NEWS

Annual Student Reception

The annual Student Reception given by the President and the Board of Trustees of the Society to the visiting students was one of the outstanding successful events of the 1936 Meeting. The Student Branch of Ohio State University with John F. Quirk as President, acted as hosts at a buffet supper following the reception.

In addition to Ohio State University, the universities and colleges represented by the one hundred and fifty students present were Carnegie Institute of Technology, Georgia School of Technology, Iowa State College, Missouri School of Mines and Metallurgy, New York State College of Ceramics, North Carolina State College (Raleigh Unit), Pennsylvania State College, Rutgers University, University of Alabama, University of Cincinnati, University of Illinois, Massachusetts Institute of Technology, Virginia Polytechnic Institute, and West Virginia University.

Rutgers University

The Rutgers University Student Branch of the American Ceramic Society has 19 active members and 9 associate members. Four are members of the American Ceramic Society. The officers for the current school year are as follows: *President*, Walter Hansen; *Vice-President*, Andrew Johnson; *Secretary*, Robert Hamilton; *Treasurer*, Norman W. Harris; and *Councillors*, G. H. Brown and J. R. Kauffman. Dues for the year are $2.00.

Seven meetings of the Student Branch were held in 1935. Average attendance was 20 members and 10 guests. Lectures and discussions by prominent men in the ceramic field were presented before the Branch.

Annual visits from the Secretary or President of the American Ceramic Society are suggested as a way in which the Society could help this Student Branch.

—J. R. KAUFFMAN, *Councillor*

University of Illinois

The University of Illinois Student Branch of the American Ceramic Society for 1935–36, sponsored and aided in the Ceramic Department's part of the Engineering Exhibit. The Exhibit showed (1) the methods of preparing, forming, and firing pottery ware; (2) the machines, kilns, and apparatus of the kiln house and the laboratory; and (3) the method of enameling. Orange and blue enameled U. of I. souvenirs were given to guests.

The following officers were elected for the year 1935–36: *President*, Rexford Newcomb; *Vice-President*, John Stevens; *Secretary-Treasurer*, Walter Turner; and *Faculty Adviser*, R. K. Hursh.

The Ceramic Smoker and the membership drive netted forty-five members, and the average attendance has been forty-five persons, including faculty and guests.

The outstanding speakers of the year have been B. T. Sweely of the Chicago Vitreous Enameling Co., who spoke on "Process Control," and Robert Stevens, of the Acme Brick Co., who spoke on "De-Airing."

Plans for the Annual Pig Roast to be held May 15, 1936, are being made.

A good representation attended the Annual Meeting of the Society in Columbus.

—WALTER TURNER, *Secretary-Treasurer*

NOTES AND NEWS FOR CERAMISTS

P. P. Budnikoff Honored by Czechoslovakian Ceramists

Peter P. Budnikoff of the Charkoff (U.S.S.R.) Institute of Chemical Technology was elected foreign honorary member of the Czechoslovak Ceramic Society at the eleventh general meeting of the Society held at Luhačovice, June 2, 1935.

A letter from R. Pulkrábek, President, and R. Barta, General Secretary, dated September 24, 1935, announced the honor. In part it reads as follows:

"The State Ceramic Technical School at Bekhin presents to you, in memory of your nomination, an object which has been made in their workshops. We are forwarding this to you at the same time as this letter."

Professor Budnikoff has been a member of the American Ceramic Society since 1924 and recently completed his twenty-fifth year of scientific and teaching activity.

—E. E. STEFANOWSKY

In honor of his election as foreign honorary member of the Czechoslovak Ceramic Society, the above vase, made in the workshops of the State Ceramic Technical School, Bekhin, was presented to P. P. Budnikoff by that Society.

American Foundrymen Association Awards

Heinrich Ries, in recognition of his outstanding services to the foundry industry and to the American Foundrymen's Association in the field of foundry sand research and control, has been awarded the Association's Joseph S. Seaman Medal. David McLain has been awarded the J. H. Whiting Medal in recognition of his contributions to the foundry industry in stimulating better melting practices.

Presentation of these major awards of the Association will be made at the annual dinner held during the 1936 convention May 5 to 9 in Detroit, Mich.

Dr. Ries directed scientific attention to foundry sand in a paper presented before the Association in 1905. Since 1920, when the Engineering Research Council organized a Joint Committee on Sand Research, Dr. Ries has been a leader in this field. He is a Charter Member and Life Member of the American Ceramic Society.

Air Hygiene Foundation Holds Meeting

Air Hygiene Foundation of America, Inc., held its first annual meeting in Pittsburgh, Pa., February 11.

The Medical Committee, A. J. Lanza, *Chairman*, told of collecting and evaluating available information on industrial dust diseases and disabilities resulting therefrom, and presented an outline of the type of medical control for the proper protection of employer and employee alike.

The Preventive Engineering Committee, Philip Drinker, *Chairman*, outlined a program to be followed by industries having dust problems. This plan is of equal interest to those that have not yet taken steps to determine the extent of their hazards or to apply remedial measures, and to those that already have done much in these directions.

The Legal Committee, headed by A. C. Hirth, presented an intensive study of the laws of the various states that have to do with dust in the industries and an analysis of these laws in the light of court decisions. Several states were treated in complete form to illustrate what the final report for all the states would include.

Mellon Institute reported upon studies of the hygienic, technologic, and economic aspects of the problems.

The Foundation feels that there is need for coördinated scientific investigation in the field of industrial dust. The coöperation of scientists, governmental authorities, and all industrialists concerned has been invited.

—W. A. HAMOR

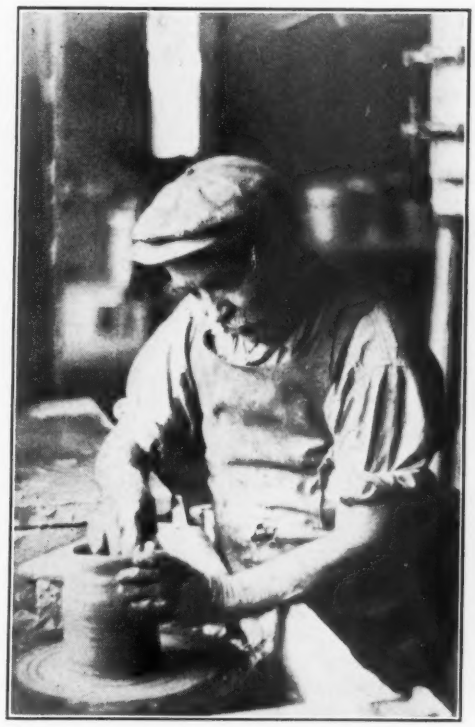
NECROLOGY

John C. Lysatt

John C. Lysatt, Technician in the Ceramic Engineering Department, Ohio State University, since 1912, died at the home of his daughter in Hendrysburg, Ohio, on January 30.

Mr. Lysatt, one of the old school of practical potters, was employed by the late Edward Orton, Jr., to impart to the students those techniques of the industry which have been so important in its development and which have been almost completely displaced by modern machine methods. In this he was highly successful.

"Dad" Lysatt, as he was affectionately known to the students, was a skilled modeler and many Columbus homes contain prized specimens of his handicraft. For many years he demonstrated the art of "turning" or "throwing" on the potter's wheel at the State Fairs and was always the center of an admiring group. His devotion to the cause of ceramic education and his patience with the students were appreciated by all his associates, and he will be remembered by the alumni of the department after much other educational material has been forgotten.



John C. Lysatt

MEETINGS SCHEDULED

American Society of Mechanical Engineers

The 1936 Annual Meeting of the American Society of Mechanical Engineers will be held November 30 to December 4, 1936, at the Engineering Societies Building, 29 West 39th Street, New York, N. Y.

—C. E. DAVIES, *Secretary*

Ceramic Association of New York to Meet

The Annual Meeting of the Ceramic Association of New York will be held May 15, 1936, at New York State College of Ceramics, Alfred, N. Y.

—M. E. HOLMES, *Secretary*

Ceramic Exposition at Rutgers University

The Fourth Ceramic Exposition will be held April 24 to May 3, 1936, at the Ceramics Building, Rutgers University, New Brunswick, N. J., under the auspices of the Ceramics Department and the Ceramic Association of New Jersey. The Exposition will be open to the public daily except Sunday, April 26. Admission is free.

Demonstrations of the basic processes employed by the silicate industries will be given. The exhibits of modern ceramic products will include the finest grade of dinnerware, glass bottles, art tile, terra cotta, brick, sinks, and other products furnished by ceramic manufacturers.

As complete an exhibit of glass products as has ever been gathered will be shown. Educational films and lectures will be presented daily.

Further information may be obtained from the Department of Ceramics, Rutgers University.

—GEORGE H. BROWN, *Director, Department of Ceramics*

Enamel Symposium at University of Illinois

The Department of Ceramic Engineering, University of Illinois, Urbana, Ill., announces an Enamel Symposium to be held at Urbana on May 9. Various subjects of current interest to enamelers will be discussed.

The following speakers will present papers after which general discussions will be held:

Kurt R. Groener, Managing Director of the Porcelain Enamel Institute, will summarize the program of the Institute. C. A. Wulf, American Valve and Enameling Company, will explain the screen process for decorating enamelware. G. H. McIntyre, Ferro Enamel Corporation, will give the modern developments in enamel control methods. W. G. Martin, A. O. Smith Corporation, will present the results of some experiments on the blasting of sheet iron. H. D. Carter will give the principles of drying and their application to enamelware.

—C. W. PARMELEE, *Head of Department*

CERAMIC SCHOOL NOTES

California School of Fine Arts

Willi M. Cohn Conducts Ceramics Courses

The California School of Fine Arts, San Francisco, affiliated with the University of California, Berkeley, Calif., has announced the appointment of Willi M. Cohn as head of the Ceramic Department for the year 1936. For the past fourteen years Dr. Cohn has done research work and served as expert consulting advisor in fundamental problems for the ceramic industry.

Mrs. Gertrude R. Wall, well-known California ceramic artist, assists Dr. Cohn, teaching the art and craft course. Dr. Cohn presents the technical course.

Objectives of the Courses

The following objectives of the courses are listed in the announcement:

(1) To give the regular student opportunity for creative expression in ceramics combined with fine craftsmanship and an understanding of ceramic materials.

(2) To give the man in the plant technical knowledge which will help him carry out his work more efficiently, whether it be pottery, terra cotta, china, dinnerware, refractories, chemical stoneware, or other ceramic products.

(3) To give the teacher a foundation for presenting ceramic projects in the schoolroom quickly and effectively.

The three phases of ceramics dealt with in the course are (1) creative and esthetic, (2) technical, and (3) fine craftsmanship.

Laboratory work is given in the new John I. Walter Ceramic Laboratory. Inquiries concerning the new courses should be addressed to the California School of Fine Arts, School Office, Chestnut and Jones Streets, San Francisco, Calif.

Iowa State College

The Clay Products Short Course of Iowa State College was held at Ames, Iowa, January 23 and 24, 1936.

The following topics of discussion and speakers were listed on the program for this meeting:

(1) "How to Minimize Effects of Pyrites," by D. A. Moulton, Ceramic Engineering Dept., Iowa State College.

(2) "Diesel Engines for Power Plants," by L. T. Brown, Mechanical Engineering Dept., Iowa State College.

(3) Motion picture on "Safety."

(4) "Electric Motors for Clay Plants," by R. H. Miller, Manager, General Electric Co., Des Moines, Iowa.

(5) Discussion on "Drying," led by D. A. Moulton.

(6) "Reinforced Masonry," by Henry Giese, Agricultural Engineering Dept., Iowa State College.

(7) "De-Airing of Clay," by Leslie R. Alt, Sioux City Brick & Tile Co.

(8) Discussion on "Grinding," led by B. W. Willson, Mason City Brick & Tile Co.

(9) "Flashing," by D. A. Moulton.

University of Washington

Studies under Way

A general series of problems dealing with the ceramic and nonmetallic mineral resources of the Pacific Northwest in coöperation with the Northwest Experiment Station, U. S. Bureau of Mines has been under way since 1919. Some of the problems and minerals studied have been the kaolins and china clays of eastern Washington and northern Idaho, their occurrence, purification, and methods of dewatering by spray evaporation, electrophoresis, and filter pressing, and their use in whiteware, refractories, and as paper filler. Attention has now been directed toward the magnesium silicates: soapstone which occurs in the Skagit River valley in northwestern Washington, talc in northeastern Washington, and olivine on Cypress Island and in the Sister Mountains near Bellingham.

Frank F. Raine, Iowa State, 1935, holder of a U. S. Bureau of Mines research fellowship, is continuing the work on the talc and soapstone of Washington, started by Joseph A. Pask, and is studying the coefficient of expansion of soapstone block, the petrographic structure of massive soapstone, their resistance to soda liquids at high temperatures, the color of the powdered products in comparison with talc products now on the market, and the use of talc and soapstone in whiteware and buff-colored pottery bodies.

Wolf Bauer, Washington, 1935, holder of the Skagit Talc Company's fellowship, has completed a preliminary geological survey of one of the Skagit River deposits and is now studying the use of soapstone in terra cotta and structural ware mixtures.

Louis H. Berkelhamer, Illinois, 1934, holder of one of the U. S. Bureau of Mines fellowships, is making a study of the occurrence, geology, physical properties, crystalline structure, and melting temperature relationships of forsterite, fayalite, and silica in order to develop a new crystalline bond for the Washington olivine.

William O. Brandt, Washington, 1935, holder of one of the Tau Beta Pi national scholarships, is studying the Washington olivine as a refractory with the assistance of Frank McKinlay, chemical engineering graduate student.

Several prospecting trips have been made by the senior and graduate members of the ceramic group to Olivine Hill, a peninsula of Cypress Island, for the collection of samples and a study of the occurrence. On the first trip, the Catalyst, an ocean-going boat belonging to the Oceanographic Laboratories of the University, was diverted to ceramic uses for the day, and a memorable cruise among the islands of the San Juan group was made. At other times fishing boats have been hired at Anacortes, overnight camping parties under the stars indulged in, and several thousand pounds of olivine rock transported to the ceramic laboratory for sample brick.

Class Research Program

Regular class research work this year has taken the ceramic group into sheet-iron enamels, the cause of mat texture in enamels, and selenium red glazes.

Research work of the upper classmen include development of terra cotta glazes and colors by Graham G. Smith, new pottery glazes and colors by Katherine E. Denny and Jesse O. Wilkinson, and vitrified bonds for Alundum grain by Gerald Kravik.

Other completed or nearly completed coöperative problems with the U. S. Bureau of Mines include: "Occurrence and Preparation of Limestone and Chalk for Whiting" (with Kenneth E. Skinner), a completed study of the chalks and whitings of the United States in comparison with the imported whitings: "The Production and Use of Quartz Sand Washed from the P.N.W. Kaolins" (with Frank Zvanut), which is being printed by the University Engineering Experiment Station; "Some Data on the Classification of Quartz and Muscovite," (with George E. Middleton) and the "Use of Washington Quartz Sands for Glass, Foundry and Abrasive Service," (with Albert H. Couch).

News from Recent Graduates

J. Gordon Adderson (B.S. 1934), ceramic engineer for the Gladding, McBean and Company, Glendale, California, has completed his first year's work in constructing a new railroad tunnel kiln and tile addition to the Glendale plant.

Frank Zvanut (M.S. 1933) spent the summer in research work in enamels at the Ferro Enamel Corp., Cleveland, Ohio, and is again teaching and completing the requirements for his Doctor's degree at Rolla, Missouri.

George Middleton (M.S. 1934), with Leroy Backus and William Lewis have started a pottery in Seattle, designing their own equipment which includes a 35-foot railroad-tunnel kiln.

Alfred H. Couch (M.S. 1935) is working on new developments for the Libbey-Owens-Ford Glass Company at Toledo, Ohio.

Joseph A. Pask (M.S. 1935) has a position as ceramic engineer for the Willamina Clay Products Company of Portland and Willamina, Oregon. This company manufactures a white face brick of a clay which vitrifies at cone 04 and a white fire brick which occurs as a capping rock of one of Oregon's buttes.

Wurth W. Kriegel (B.S. 1932) has charge of the ceramic research and instruction in the latest ceramic engineering school at the Montana School of Mines, Butte, Montana. This State will be heard from in the future for chromite, vermiculite, and light colored clays.

A. L. Bennett (M.S. 1922), John R. Gednetz and H. R. Goodrich (1923) are busy in the further development of the new Franciscan talc pottery of Gladding, McBean and Company at Glendale, California.

—HEWITT WILSON, *Head of Department*

Tile and Clay Products Exhibited

Displays of tile and clay products are among the outstanding exhibits in the Palace of Better Housing at the 1936 California Pacific International Exposition, held in San Diego from February 12 to September 9, 1936.

Pacific Coast tile, clay products, and pottery makers have on display every type of ceramic work which can be included in modern buildings.

Whole rooms and ornamental work on walls, floors, and walks are shown. Entire units are assembled to show color effects.

As a result of the increase in the use of Spanish and Mexican architecture along the Pacific Coast, roof tiling has almost displaced shingles for residence covering.

Porcelain Enameled Appliances Featured on Armco Program

Porcelain-enameled kitchen ranges, refrigerators, washing machines, and formed metal plumbing ware were the products featured in the "Ironmaster" chats on four Armco Concert Band radio programs over the National Broadcasting Company Blue network in February and March.

E. P. Rexford Joins Harbison-Walker Research Staff

E. P. Rexford has recently been made a member of the research staff of the Harbison-Walker Refractories Co. Mr. Rexford is well-known through his publications on the subject of the effect of boiler-furnace slags on refractories. This work was carried out under the direction of a Special Committee on Boiler Refractories for the American Society of Mechanical Engineers. Mr. Rexford is a graduate of Massachusetts Institute of Technology and also holds a Master of Science degree from that Institution. For a number of years he was employed in research work by the National Bureau of Standards, Columbus, Ohio, Station.

WOULD YOU

1. Pay $4.17 for a report of original research?
   In 1935 you got 76 such reports at this cost.
2. Pay $4.17 to some one for an abstract of an article?
   In 1935 you got over 4000 of them at this cost.
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These Total the $12.50 Personal Membership Dues

COMMUNICATIONS—CERAMIC HISTORY

THE STORY OF GLASS*

By J. C. Hostetter

This is a short story about an interesting combination of the earth's elements. Transparent, water white, or colored, in endless forms, it is of the greatest importance to all of us. We have come to depend upon it for all manner of uses, in our homes and in our industries. We are just beginning to appreciate the vast unexplored phases of our present civilization to which it can be applied. I refer to glass, a substance as old as the earliest arts of the fire, and a substance as new as the much-popularized science of air conditioning.

All types of people in all walks of life are influenced by the glass around them every day. Let their homes be estates or cottages; let their work be in skyscrapers or in hay barns, glass is a part of their living. We are accustomed to living in houses with glass windows that keep out germ-carrying dirt and keep us warm in the winter, while allowing the precious sunlight to brighten our lives indoors. The food that we eat and preserve is often made in glass and packed in glass. We receive our milk in glass bottles. We drink from glass tumblers. Many of us read with the aid of glass lenses. The tables and shelves in our homes are enhanced by the glass art objects that adorn them. This radio program reaches you by means of radio waves that are being sent out from networks of wires that are insulated with glass. All these modern uses of glass, and the uses to come, are the result of centuries of activity in the field of glass manufacture. Let us dwell for a brief moment upon the history of man's most versatile creation.

The first glass is reported by the historian Pliny to have been made by the Phoenicians on the eastern shores of the Mediterranean. As early as 4000 B.C., however, we find the first recorded glass objects in the tombs and temples of Egypt. They are in the form of jewelry and ornaments. The Roman conquerors of Egypt brought back to their native land the most highly skilled workers of glass. In the first centuries of the Christian era, the luxury of glass was enjoyed in the use of glass mosaic pavements and glass-covered walls.

Venice eventually became the European center for glassworkers, and it was here that the glassmaking art was restricted to the nobility of the Medieval period. At the same time, fine work in glassmaking was done also in Germany. It is from this country today that we obtain our Christmas tree ornaments.

Glassmaking in America is as old as our colonization. First started, in 1608, at Jamestown, Virginia, the new industry later gained a firm foothold in Massachusetts in the vicinity of Boston. It was in this state that Amory Houghton got his start in the glass industry. Houghton later, in 1868, founded the Corning Glass Works.

In the eighteen-seventies it was a matter of concern that the existing railroad lamps failed to flash their red warning color in foggy weather, just when it was needed most. This unfortunate situation was due to the wrong kind of red glass being used in the lanterns. The Corning Glass Works, through an invention of one of its founders, was able to supply the railroads of the country with lantern globes whose glass gave off a brilliant red light in all kinds of weather. This development and a later one, a corrugated lens, played an important part in the progress which our railroads have made in safe operations. The safety record for all American railroads for 1935 shows that we have come a long way.

In 1878, when Thomas Edison needed a bulb for his new electric lamp, he came to the glassworks in Corning. Realizing the need for a bubble of thin glass to inclose the filament and maintain a vacuum around it, he asked Charles Houghton whether Corning Glass Works could make the bubble. Houghton's men blew for Edison the first commercial electric light bulb. Thus, Corning commenced the manufacture of bulbs for an industry that was destined to become one of the largest in the world.

Few people realize the importance of uniformly accurate thermometer tubing. In 1896 Arthur A. Houghton invented the method for drawing thermometer tubing vertically. Now, at Corning, thermometer tubing is vertically drawn from hot glass in a twelve-story tower. It is perfectly formed with none of the twisting defects that came from the old horizontal drawing method.

At the turn of the century, Corning decided to engage even more extensively in glass research. In 1908 a group of scientists began to engage in chemical and physical research and this has led eventually to such outstanding results as the birth of Pyrex brand glass baking ware for the home and the creation of the largest telescope mirror the world has ever known.

Pyrex brand glass is a commodity that can stand heat and cold. This low-expansion, heat-resistant glass, developed by our research staff, has found use in homes and industries where it is subjected to repeated temperature changes. Probably the most important scientific use of this glass has been in the field of laboratory glassware. During the World War, we were able to supply our government with laboratory glassware that exceeded in quality the supplies which had previously been obtained from Germany and which were then being curtailed. Today, Pyrex brand glass is also being used in factory pipe lines where visibility and cleanliness of the liquids flowing through them are desired. No doubt you have read in the papers lately of

* Radio address delivered over station WGY and its affiliated short-wave station, Schenectady, New York, February 28, 1936. Received March 8, 1936. J. C. Hostetter is Director of Research and Development, Corning Glass Works, Corning, N. Y.

the new Pyrex brand Top-of-Stove ware. This is the most recent application of these versatile super-glasses. With these new dishes the housewives can cook, serve, and store the food in the same utensil. The new glass is so constituted that it can come in contact with the flame without fear of damage.

This week's newspapers have been featuring some remarkable pictures of the 200-inch telescope mirror which is now ready to be shipped to California. It is interesting to know that this giant "eye" is made of a low-expansion Pyrex brand glass of the same family as the casserole on your dinner table. Think of it! Eating from the same kind of glass that is soon to make history in the hands of the astronomers. This mighty mass of glass, a 20-ton eye for the world, will aid scientists to explore the heavens to an extent that is 27 times greater than ever before. They will see three times further into space. They will take star pictures ten times faster. The mysteries thus explored will, in their ever-increasing grandeur, assure us anew that "the Heavens declare the Glory of God." Frank W. Preston[1] spoke truly when he recently said "glass is the window to the universe."

Sometimes novel effects can be secured by removing some impurity from a batch of glass. In this manner was produced the glass that transmits the ultra-violet rays of sunlight. Ordinary window glass contains as an impurity sufficient iron oxide to absorb the ultra-violet rays. Remove this impurity and the health-giving rays pass through. But this same iron oxide is deliberately added when we want to prevent the passage of heat rays from the sun, which has decided advantages in glass used in air-conditioned cars and buildings. Thus, glass from which iron oxide has been removed has been of inestimable value to poultrymen; glass to which iron oxide has been added has been of great value to the building trade.

Entirely different again is glass in the form of fine fibers. Imagine if you will, a fiber of glass $^1/_{20}$ the diameter of a human hair, soft, flexible, and so fine that a pound of it would reach around the world. Such is one of the newest glass products that has opened up tremendous commercial possibilities. In yarn composed of long individual fibers we have the basis for a new textile material, fireproof and permanent. In the form of a felted mass of intertwined fibers, we have an excellent insulator against heat or cold and a sound-proof medium. Houses insulated and sound-proofed with glass, theater curtains and hangings of glass fabrics, and large sculptured glass panels, giving the artist a new medium of expression, all these usher in a new era of glass architecture.

I have endeavored to tell of glass as a material of many types, forms, and uses. The imagination is fired as one contemplates the many interesting and useful properties possible in one material—brilliant as the diamond, fiery as the opal, colorful as rainbows in all their glory; light and delicate as the spider's web, or huge and massive as a twenty-ton mirror; fragile as an eggshell, or strong as steel. Truly, glass is a universal material, the servant of man, the spyglass of science. Without it, the age of darkness; by its aid, science and civilization move on.

[1] Glass technologist, Butler, Pa.

NEPHELINE SYENITE*

By C. L. Cruikshank

Nepheline syenite is an igneous rock composed principally of feldspar, nepheline, mica, and magnetite. In Methuen Township in Peterboro County, Ontario, there is a huge mountain of syenite rock which has intruded into a granite formation. The nepheline syenite mass is unusual in that it is uniform and free from intrusions of foreign rocks.

Until two years ago, the rock had been considered worthless from a commercial standpoint, due to the presence of iron in the form of magnetite, this mineral occurring in small crystals which can not be cobbed out by hand methods. The presence of the mineral, nepheline, in the syenite tends to raise the aluminum-oxide content which would make the rock more valuable than feldspar in the glass industry.

The recent development in the field of magnetic separation in the use of the high intensity gravity rotor-type machine makes it possible to extract mica and magnetite from feldspathic rocks with a very small loss. In 1933, 500 pounds of the nepheline syenite at Methuen was sent to the Dings Co. in Milwaukee, with the result that a concentrate was produced with the iron oxide brought down to 0.07. The complete analysis of the concentrate showed more than 24% aluminum oxide as compared to 18% in the average feldspar. It further developed that the concentrate had a higher combined alkali content together with a lower fusion point.

The 500 pounds of concentrate was sent to a Canadian glass manufacturer for test with the result that it was proved that 375 pounds of nepheline syenite would replace 500 pounds of Canadian feldspar. Feldspar is used in the glass industry as a means of introducing aluminum oxide into the glass batch because this oxide gives the glass greater brilliance and better working qualities. Other things being equal, the feldspar having the highest alumina content is the most valuable, showing the importance of nepheline syenite concentrate to the glass industry.

The deposit of nepheline syenite at Methuen is a surface formation rising 300 feet above the waters of Stony Lake. There is no overburden and the cost of mining is low enough to offset any additional expense incurred in removing the iron. In fact, the mining cost is almost low enough to offset also the 25-mile truck haul to rail. In most feldspar operations, there is a long haul to rail and, in many instances, the distance is more than 25 miles. There is, then, as a net advantage, the natural superiority of the product over feldspar.

* Received December 8, 1935.

Development

Because of the favorable results obtained from the first sample of material, the Canadian glass company ordered a carload for test in actual operation. At this time a small syndicate was formed in Toronto and the properties at Methuen were purchased, about 600 acres in all, embracing the entire occurrence of syenite at this point and as far as we have been able to discover, the only occurrence which is uniform enough for commercial exploitation.

A carload of rock was blasted down and shipped to Blasdell, N. Y., for concentration. Twenty tons were shipped to Canada and ten tons were retained by the writer in Blasdell to be used for test purposes in this country.

The carload shipped to Canada verified the test of the first 500 pounds, and the material met with the approval of the technical men in charge, due to the large saving involved in the use of nepheline syenite.

In this country, A. S. Watts, Dept. of Ceramic Engineering, Ohio State University, was engaged to run tests to determine the value of the rock in ceramic bodies. An encouraging report was made concluding with the following statement. "I believe this material has properties which would seriously warrant its introduction as a feldspar substitute in many ceramic bodies."

Tests were run and analyses made in the leading glass factories and in many large potteries. In every case, the tests led to the approval of the concentrate and to an inquiry as to when this material could be purchased. This has taken a long period of time. Freight rates are being established and the process has been improved to the point where the loss in separation has been reduced 50%.

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SECOND INTERNATIONAL CONGRESS ON GLASS*

BY W. E. S. TURNER

The interests of those whom we expect to attend the Second International Congress on Glass to be held in England this year are so many and so varied that it has been found impossible to limit the number of subjects to fewer than twenty. In these circumstances it is proposed to classify the subjects into four groups and to arrange, at least in the cases of three of these groups, to meet simultaneously.

The program outline is as follows:

GROUP I

(1) Glass technological literature.
(*a*) Nomenclature and definitions.
(*b*) Abbreviations in the literature.
(*c*) Stimuli to international exchange of directories and bibliographies.
(2) Specifications and standards for glassware and methods of testing.
(*a*) Information about existing control bodies and their methods.
(*b*) Suggestions for safeguarding glass technological control, national and international.

GROUP II: MANUFACTURE AND PROPERTIES OF GLASS

Sub-Group 1

(1) Methods of analyzing raw materials and glasses.
In particular, the determination of traces of iron in raw materials and in glass.

Sub-Group 2

(1) The problem of decoloring glass, including methods of determining color tint.
(2) The chemical corrosion of glass.
(*a*) A standard method of test for glass as glass. Comparison of American, English, and German methods based on use of glass powder. Control of glass grinding and sieving to ensure uniformity of grain size.
(*b*) Methods applicable to certain glass articles (bottles, chemical glassware, ampoules, and so forth).
(3) Mechanical strength of glass.
(*a*) Methods of measurement and the factors which influence results.
(*b*) Interpretation of measurements.
(4) Thermal endurance of glass.
(*a*) A general method for determining the thermal endurance of glass as glass.
(*b*) Methods applicable to certain forms of glassware.
(5) Annealing temperature.
Its definition and relation to softening temperature and in particular to viscosity.

GROUP III: REFRACTORY MATERIALS, FUELS, AND FURNACES

(1) The testing of tank blocks.
(2) Refractory packings: properties, shapes, and sizes.
(3) Nomenclature and formulas relating to glass furnace performance.
(4) The cooling and the insulation of furnaces.
(5) The flow in glass in tank furnaces.

GROUP IV: THE MANIPULATION, FORM, DESIGN, AND DECORATION OF GLASS[1]

(1) Special metals and alloys in glass manufacturing processes.
(2) The design of machine-produced domestic glassware.
(3) The use of sandblasting as a decorative treatment for glass.
(4) Glass decorators of about 1800: German and English relationships.
(5) Examples illustrating the present-day development of glass decoration in Germany.
(6) Visits to the British Museum and the Victoria and Albert Museum.

* Received February, 1936.

[1] This list of subjects is provisional.

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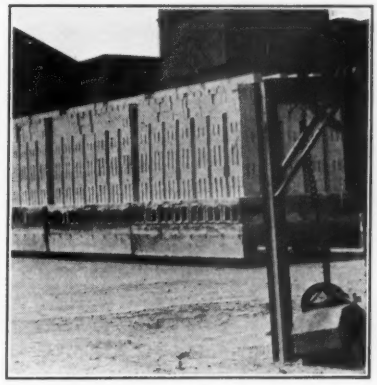

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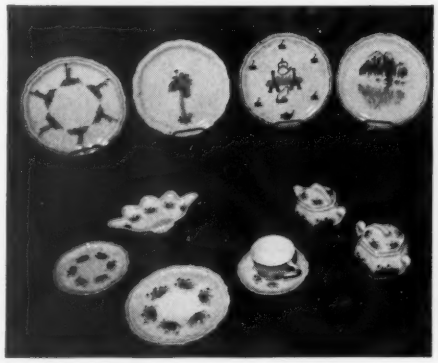

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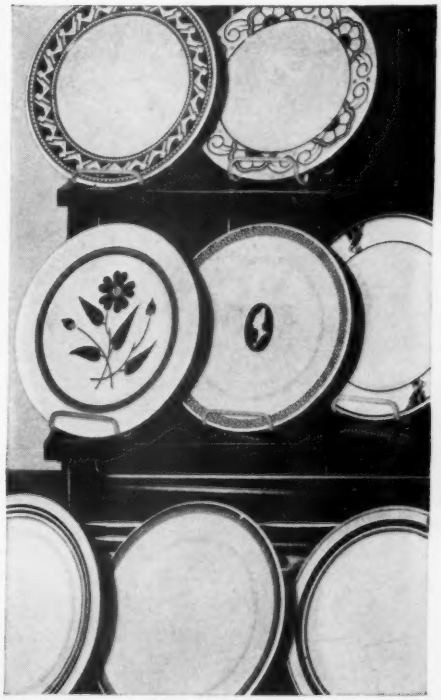

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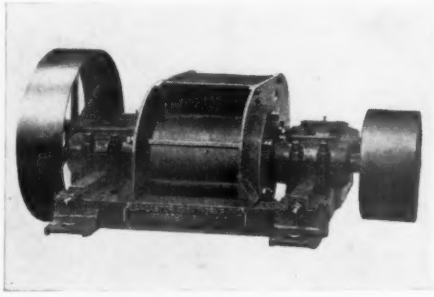

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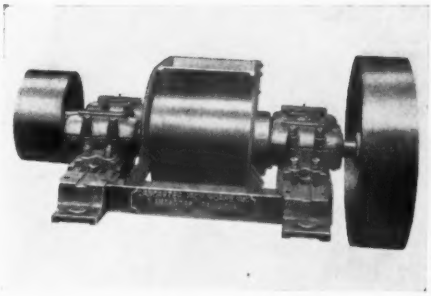

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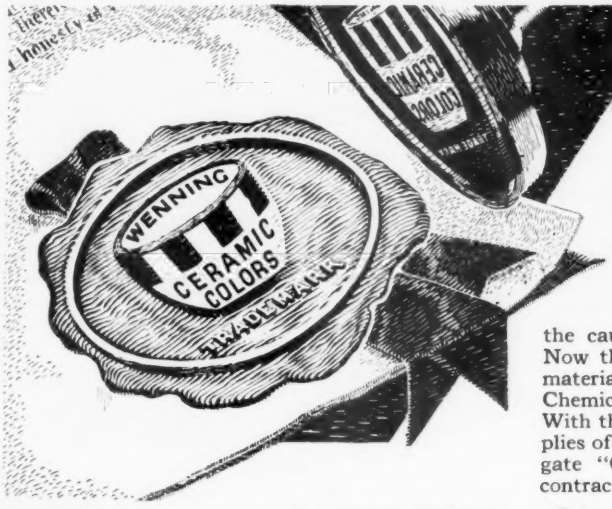

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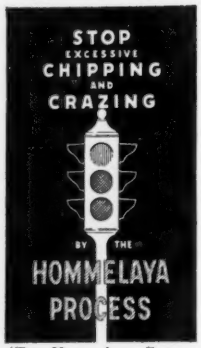

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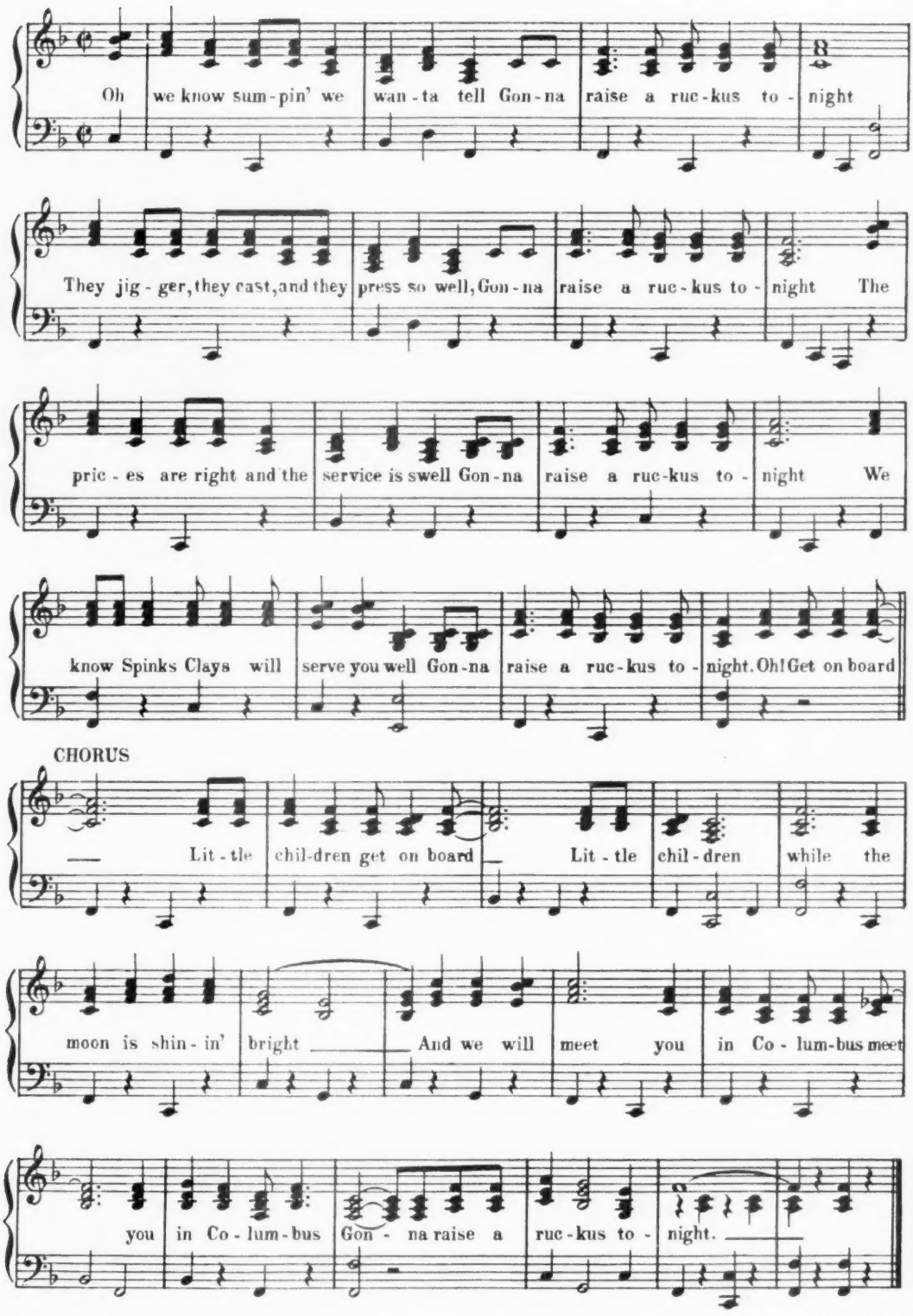
RUCKUS

Oh we know sum-pin' we wan-ta tell Gon-na raise a ruc-kus to-night
They jig-ger, they cast, and they press so well, Gon-na raise a ruc-kus to-night The
pric-es are right and the service is swell Gon-na raise a ruc-kus to-night We
know Spinks Clays will serve you well Gon-na raise a ruc-kus to-night. Oh! Get on board
CHORUS
Lit-tle chil-dren get on board Lit-tle chil-dren while the
moon is shin-in' bright And we will meet you in Co-lum-bus meet
you in Co-lum-bus Gon-na raise a ruc-kus to-night.

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